Smart Grid and Grid Modernization Abroad: Examples of Major Priorities, Programs, and Initiatives

Russell Conklin, U.S. DOE
Vice Chair, Executive Committee, ISGAN
"Tools for the Smarter Grid" • 14 April 2016 • Brookhaven National Lab

Accelerating the Transition to Clean Energy Technologies

Agenda

- About ISGAN
- Selections from…
  - *Korea*
  - *India*
  - *Singapore*
  - *Japan*
  - *Italy*
  - *Canada*
  - *Mexico*
  - *GRID4EU*
  - *ELECTRA*
  - *ETP Smart Grids*
  - *ERA-Net Smart Grids Plus*
- Links

International Smart Grid Action Network =

Strategic platform to support high-level attention and action for the accelerated development and deployment of smarter, cleaner electricity grids around the world.

ISGAN activities are meant to…

- call attention to the importance of electricity grids for clean energy
- build a better global understanding of smart grids
- improve knowledge exchange among experts and practitioners
- address gaps in knowledge and tools
- recognize excellence in smart grids projects and programs
- support replication of proven ideas

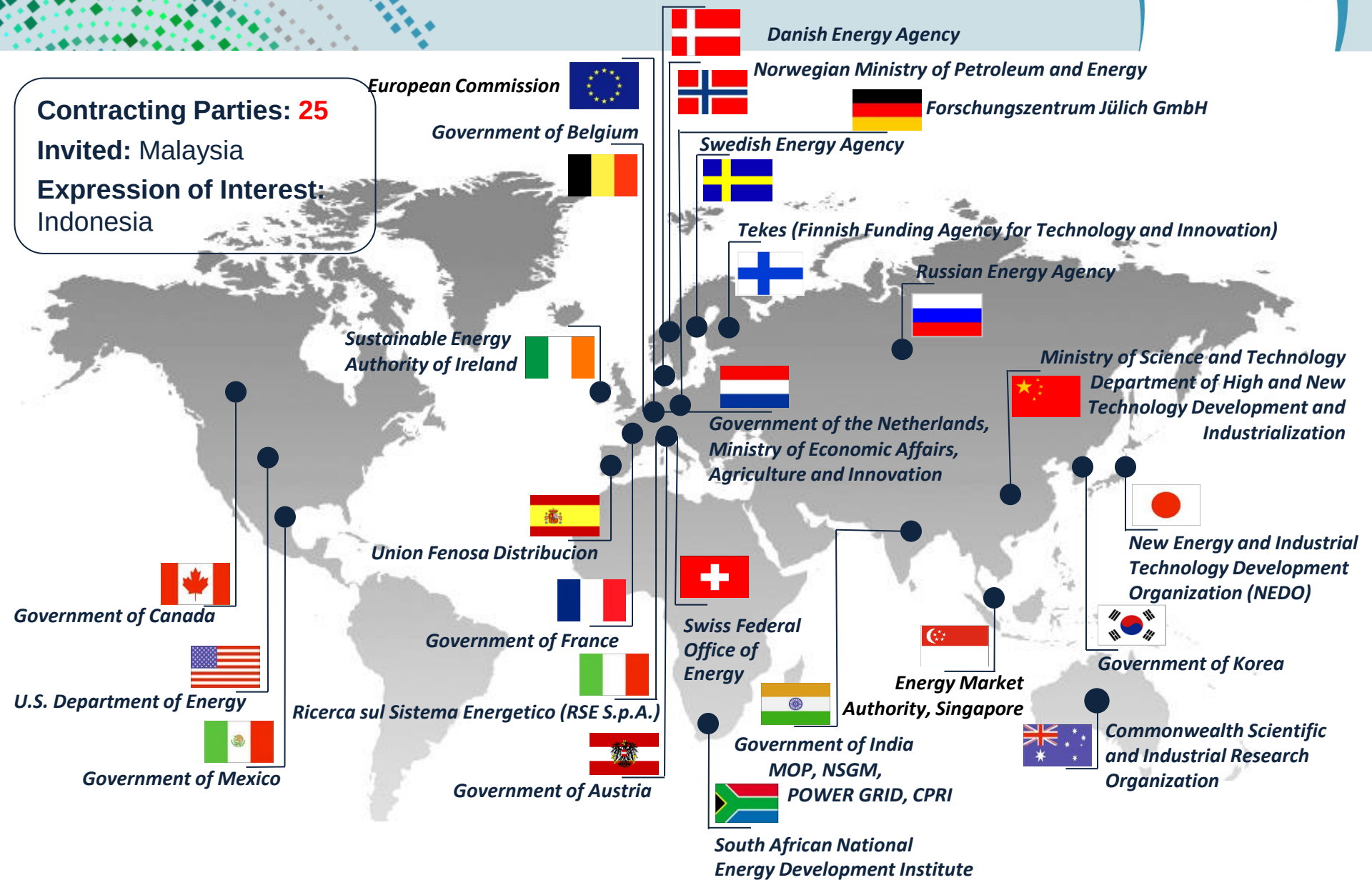
Visit **iea-isgan.org**

Participants

Contracting Parties: 25

Invited: Malaysia

Expression of Interest: Indonesia



ISGAN is part of CEM process

CEM7 - 2016
United States

San Francisco, California, June 1-2, 2016

CEM1 - 2010
United States

CEM2 - 2011
United Arab Emirates

CEM3 - 2012
United Kingdom

CEM6 - 2015
Mexico

CEM4 - 2013
India

CEM5 - 2014
Korea

CEM7, San Francisco, CA, June 1-2, 2016

- **Startups and Solutions Showcase** of technologies and innovation
- **Public-Private Action Summit,** featuring announcements of award winners, launch of new high-level campaigns, release of new reports, etc.
- Closed-door **Ministers' Discussions**; invitation-only **Roundtables**
- **Side events with involvement of WBCSD, GO15, REN21, and more…**
- **CEM7 website: http://cem7.org/**

6

Korea

01 Government's SmartGrid Vision

Vision

Low Carbon, Green Growth Society

Target

Strategic Direction

Country	Enhancing Energy Efficiency and Cutting CO_2 Emission
Enterprise	New Growth and Export Engine
Individual	Improvement in Quality of Life

SmartGrid Category

Smart Power Grid	Smart Customer	Smart Transport	Smart Renewable	Smart Elec. Service

04 Implementing MicroGrid

		In Operation	On the Way	
		 Gapa Island	 Deokjeok Island	 Ulleung Island
Area/ Population		0.85㎢ / 281	22.97㎢ / 1,919	0.85㎢ / 281
Customers		193	1,000	193
Configuration		WT + PV + ESS + AMI	WT + PV + ESS + EMS + Geothemal	WT + PV + Hydro + ESS + Geothemal + EMS
Main Characteristics		Carbon Free Island (KOREA's First)	Ecooly Energy Independent Island (Stabilizations, Optimization)	Green Energy Independent Island (Economic feasibility + Supply reliability)
Status		Operating (2013 ~)	Project Started (2015)	Project Started (2015)

06 SmartGrid Station

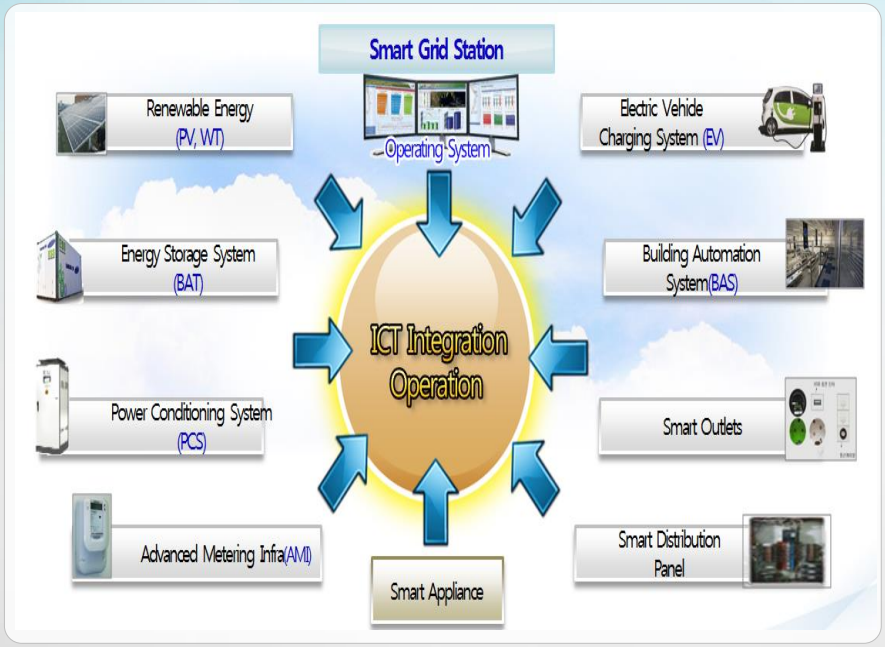
Definition and Composition

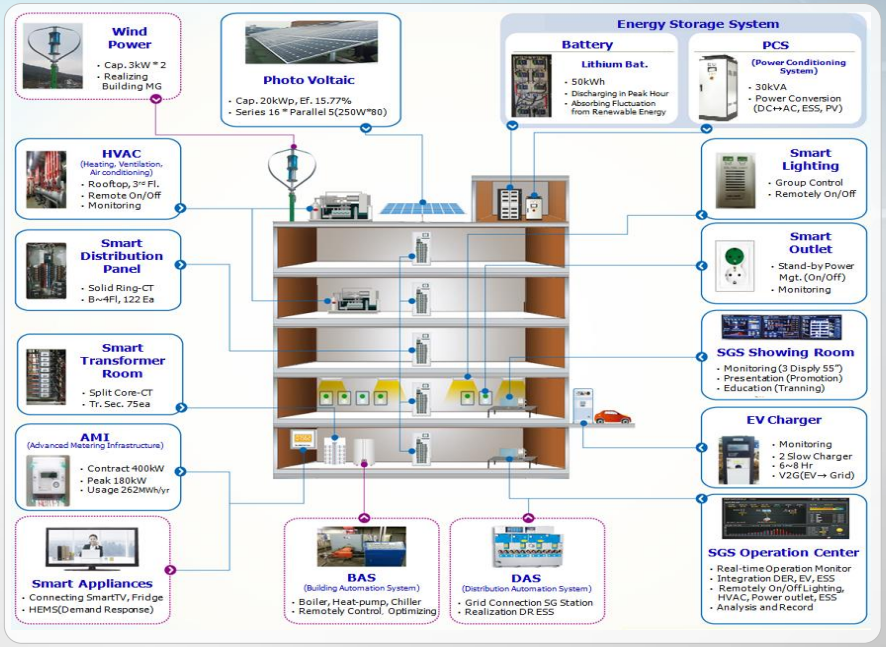
SG Station

Renewable Energy + Energy Storage System + Building Automation System → Intergrated Operation Center

Power Consumption 10% ↓, Peak 5% ↓, Peak Load Consumption 15% ↓, CO_2 5% ↓

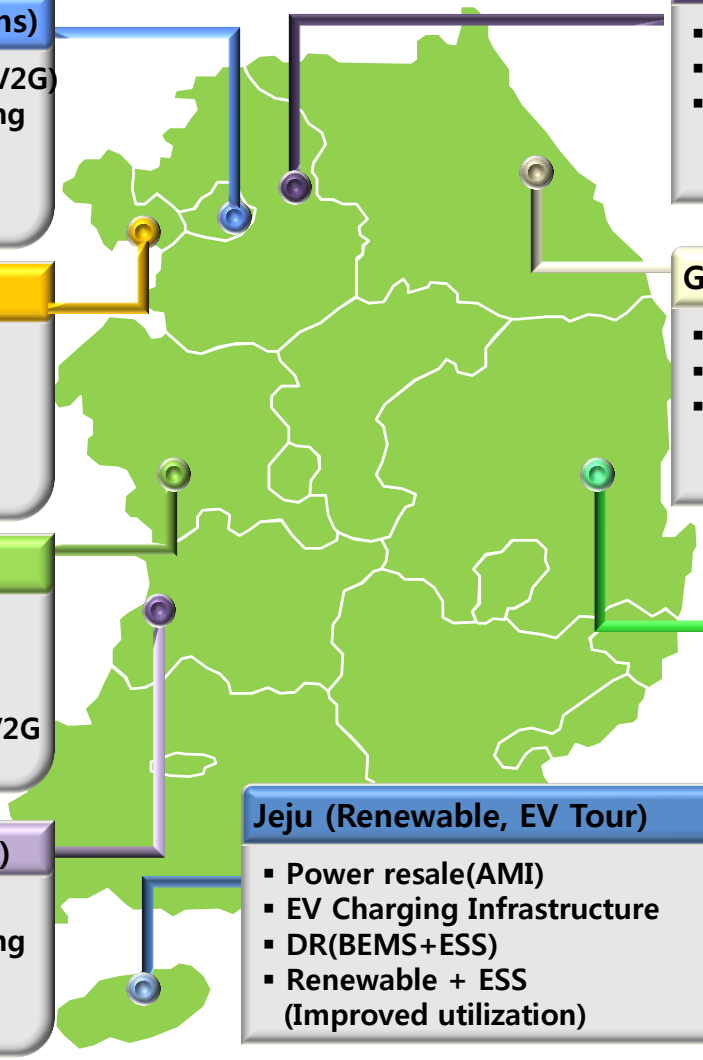
Component of SG Station





1-2. Nation-wide SG Expansion Project

Regional Business Model



Seoul (Educational institutions)
- Power Trading by DER(ESS, V2G)
- EV Charging Infra, Car Sharing
- Power resale(AMI)

NamYangJu (Complex Town)
- Power Trading by DER(ESS, V2G
- EV Charging Infrastructure
- Energy Consulting(AMI)

Inchun (Industry Complex)
- DR(BEMS/FEMS+ESS)
- EV Charging Infrastructure
- Energy Consulting(AMI)

Gangreung (Eco-Friendly Town)
- Energy Consulting(AMI)
- EV Charging Infrastructure
- Renewable + ESS (Improved utilization)

ChungNam(New Town)
- DR(BEMS+ESS)
- EV Charging Infrastructure
- Car Sharing
- Power Trading by DER(ESS, V2G

KyungBuk(Educational institutions)
- Power Trading by DER(ESS, V2G
- EV Charging Infrastructure
- Renewable + ESS (Improved utilization)

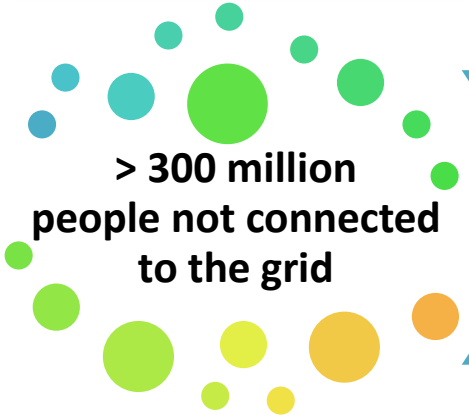
Jeju (Renewable, EV Tour)
- Power resale(AMI)
- EV Charging Infrastructure
- DR(BEMS+ESS)
- Renewable + ESS (Improved utilization)

JeonBuk (SaeManGum Area)
- Power resale(AMI)
- EV Charging Infra, Car Sharing
- DR(BEMS+ESS)

India

Electricity Challenge in India

India operates one of the largest synchronous grids in the world – covering an area of > 3 million sqkm, 290 GW capacity and >200 million customers



> 300 million people not connected to the grid

Per capita consumption of electricity is ¼ of world average

Estimated demand in India by 2032 is 900 GW -

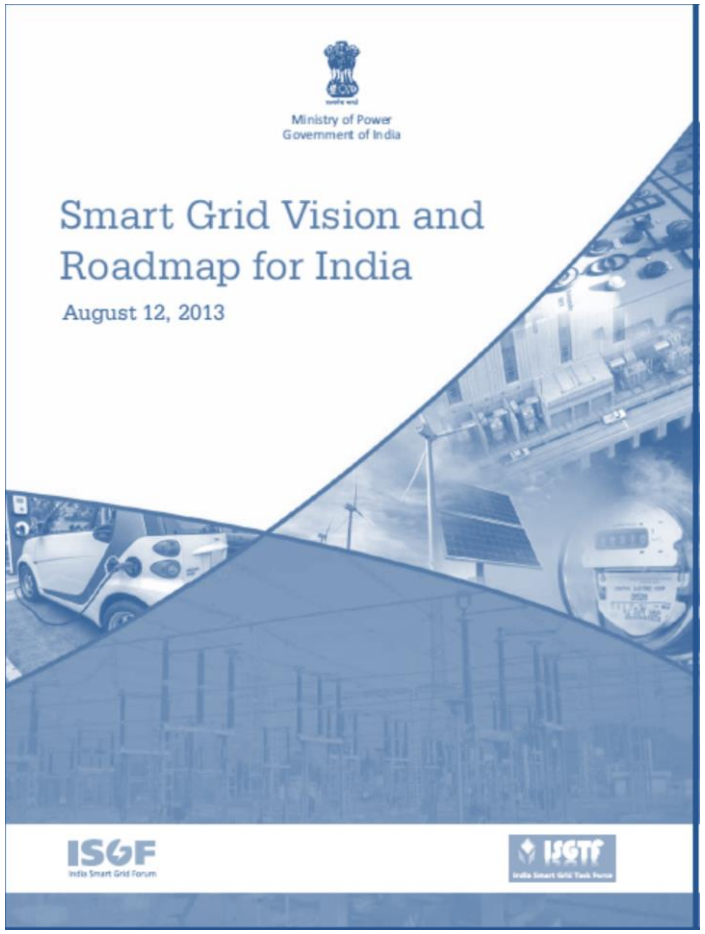
3X that of now

To address the above challenges, the Indian power system is expected to grow **8-10% p.a.** for next **several decades** - managing a rapidly growing power system of this size requires smarter systems

Developing countries like India need to invest in both strengthening the electrical network as well as adding communications, IT and automation systems to build a strong and smart grid

Smart Grid Vision and Roadmap

Ministry of Power (MoP) in consultation with the India Smart Grid Forum and India Smart Grid Task Force has formulated a **smart grid vision and roadmap for India**, aligned to MoP's overarching objectives of **"Access, Availability and Affordability of Power for All"**



Smart Grid Vision for India

Transform the Indian power sector into a secure, adaptive, sustainable and digitally enabled ecosystem that provides reliable and quality energy for all with active participation of stakeholders

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National Smart Grid Mission

http://www.nsgm.gov.in

1. Mandate from 2013 Smart Grid Vision and Roadmap to **National Smart Grid Mission (NSGM) to accelerate deployment of smart grids**.
2. Prime focus of Smart Grid projects is on **loss reduction, improvement in quality of supply** and **managing increasing penetration of distributed Renewable Generation and Electric Vehicles**.
3. NSGM approved in March 2015 to plan and monitor implementation of policies and programs related to Smart Grid activities in India with investment of around USD 150 Million
4. To begin with, **20 smart cities** declared to be covered for smart grid implementation.
5. NSGM Project Management Unit (NPMU) created under Director, NSGM which **is the single point contact on Government of India's view** regarding Smart Grid implementation.
6. Around **10 Pilot Projects are in advanced stages of implementation**. Learning from these pilots will help formulating strategy and policies for new projects.
7. Two projects are under approval with NSGM with consumer base of around 175 000 and investment of around USD 17 million. Many more are in pipeline.

Glimpses of Other Major Distribution Sector Initiatives

1. Under R-APDRP / IPDS scheme several building blocks of Smart Grids (GIS Mapping, IT Networks including Data Centres, SCADA/DMS, Billing/CRM Systems, Infra upgrade etc.) being created in urban areas (Investment of around USD 10 billion USD).
2. DDUGJY scheme for **electrification of un-electrified villages**, access to 50 million households, system strengthening (Investment of another USD 11 billion)
3. Government of India approved 14 Smart Grid Pilot Projects with a consumer base of around 150,000 and an investment of around USD 65 Million of which 10 are already under implementation
4. **Vision of 24X7 energy for all by 2019.**
5. Plan to expand renewable energy capacity five-fold to **175 GW by 2022**, (100 GW Solar and 60 GW Wind power). 40 GW to come from Roof-top Solar PV alone
6. **Smart Cities Mission** envisages converting 100 cities into smart cities.
7. **UDAY Scheme** targets **Smart Metering for all consumers** consuming 200 kWh/month by 2019
8. The Smart Grid Vision and Roadmap for India envisages development of **1,000 microgrids by 2017**; another 10,000 microgrids in 13th Five Year Plan (2017-2022) and 20,000 microgrids in 14th Five Year Plan (2022-2027): total 31000 Microgrids!

Singapore

Building a Smarter Grid

- Singapore has one of the most reliable electricity systems in the world. Compared to other systems, Singapore's grid has many "smart grid features" already built in, such as the Supervisory Control and Data Acquisition (SCADA) system, which allows remote monitoring and control of key installations.

- Smart grid initiatives will build on the existing core system to continue to deliver efficient outcomes and value for stakeholders, including licensees and electricity consumers.

- Smart grid developments do not only pertain to physical infrastructure, but also encompass putting in place the policies, ecosystem and competencies within the industry to bring about the intended outcomes.

Priorities to Stay Ahead

FOSTERING INDUSTRY INNOVATION BY BEING PRO-BUSINESS

Address industry's needs and enhance the regulatory framework in order to facilitate commercially viable business models and foster a pro-business environment

ENABLING GREATER COMPETITION IN THE ENERGY MARKET

Lower barriers to entry and regulatory enhancements allow new industry players to enter the solar and electricity retail markets

CREATING ENERGY CHOICES FOR CONSUMERS

More consumers are able to benefit from different energy sources as well as innovative energy price plans

Consumers Have New Avenue to Negotiate Long Term Electricity Prices

- An Electricity Futures Market allows the trading of standardised contracts of electricity products into the future at specified prices.
- It provides a platform for generation companies to hedge their commercial and operational risks; and lower the barrier to entry for new independent retailers.
- This in turn allows consumers to **lock in long term prices**; and utilise the transparent prices provided by the futures market to **negotiate their electricity retail packages** with electricity retailers.

	Contract Month	Last	Chg From Prev Settle	Bid	Ask	Open	High	Low	Close	Vol	Open Int	Settle	Prev. Day Settle
E	Jun 15	-		70.90	94.90	-	-	-	-	-		-	101.11
E	Sep 15	-		72.05	96.05	-	-	-	-	-		-	102.90
E	Dec 15	-		74.23	98.23	-	-	-	-	-		-	105.32
E	Mar 16	-		76.71	100.71	-	-	-	-	-		-	107.75
E	Jun 16	-		79.18	103.18	-	-	-	-	-		-	109.85
E	Sep 16	-		81.42	105.42	-	-	-	-	-		-	111.91
E	Dec 16	-		83.52	107.52	-	-	-	-	-		-	113.48
E	Mar 17	-		85.75	109.75	-	-	-	-	-		-	114.24
E	Jun 17	-		87.52	111.52	-	-	-	-	-		-	-

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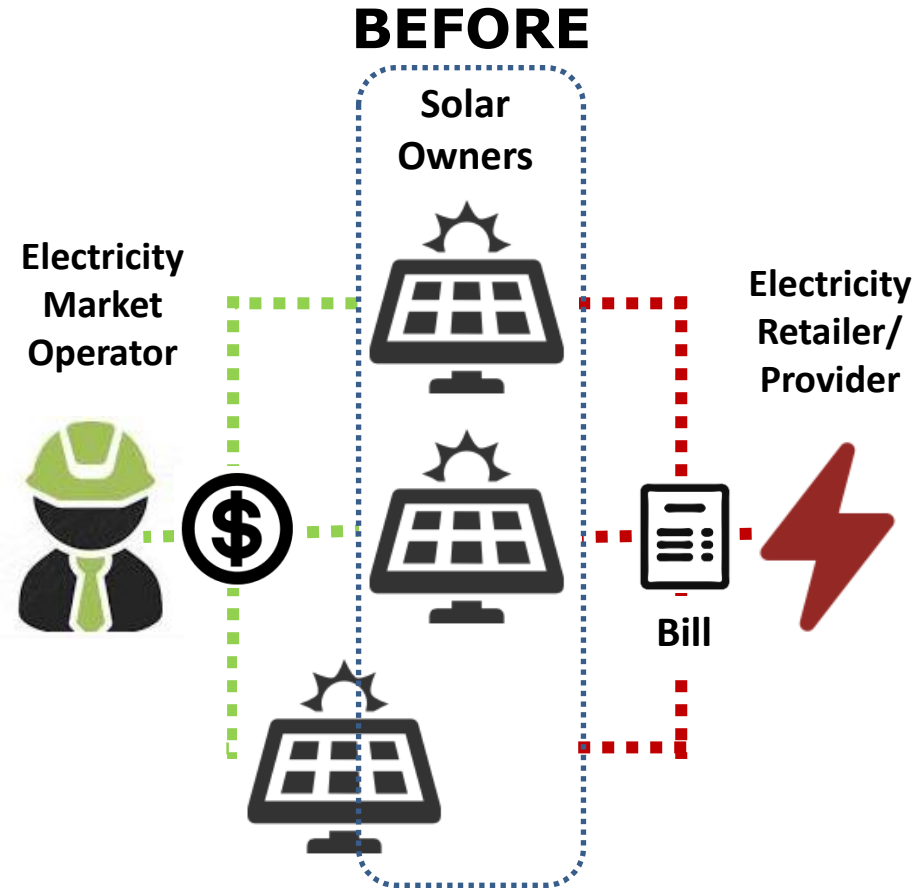
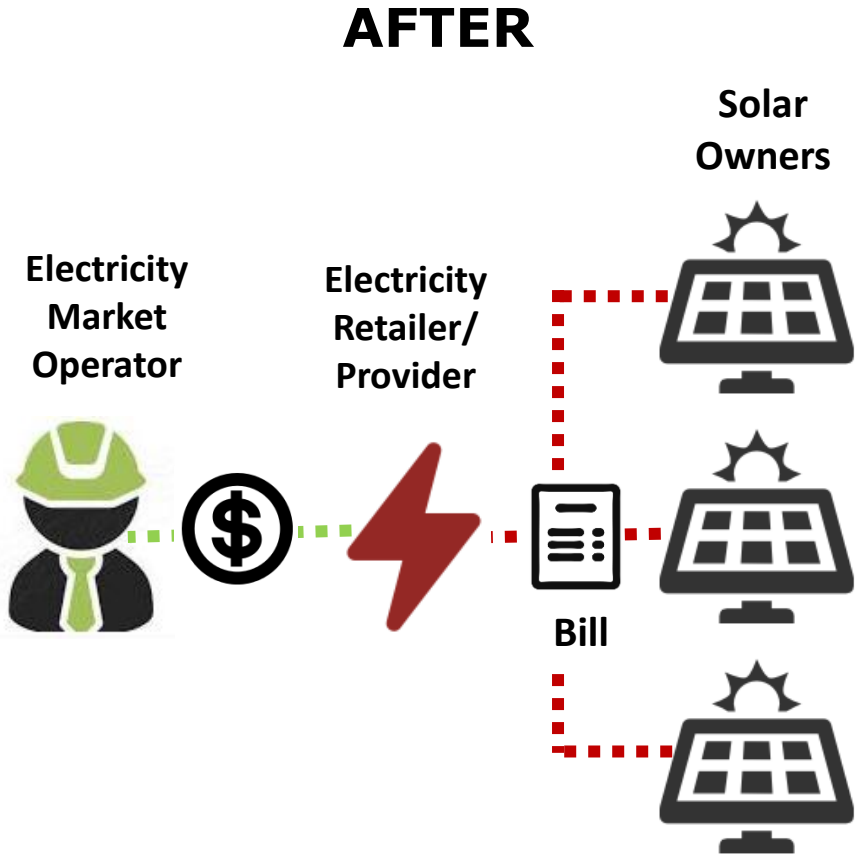
Allowing Solar "Prosumers" to Receive Payment in an Expedient and Least Effort Manner



Market registration required for payments for excess solar energy

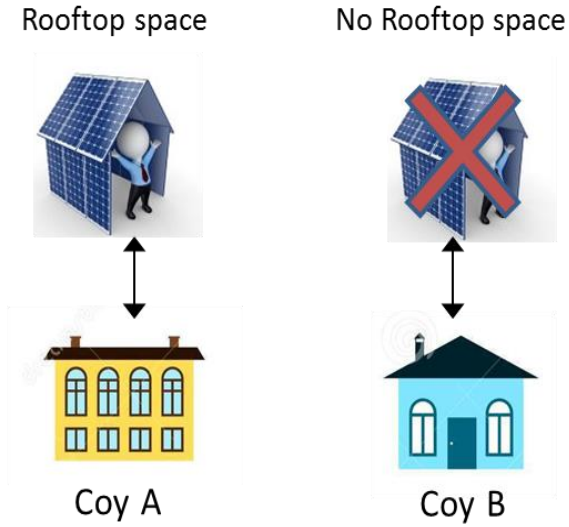


Payments for excess solar energy **through Central Intermediary** without onerous market registration

Creating Flexible System to Support Smart Business Models

Before

Solar energy is only limited to customers with rooftop space

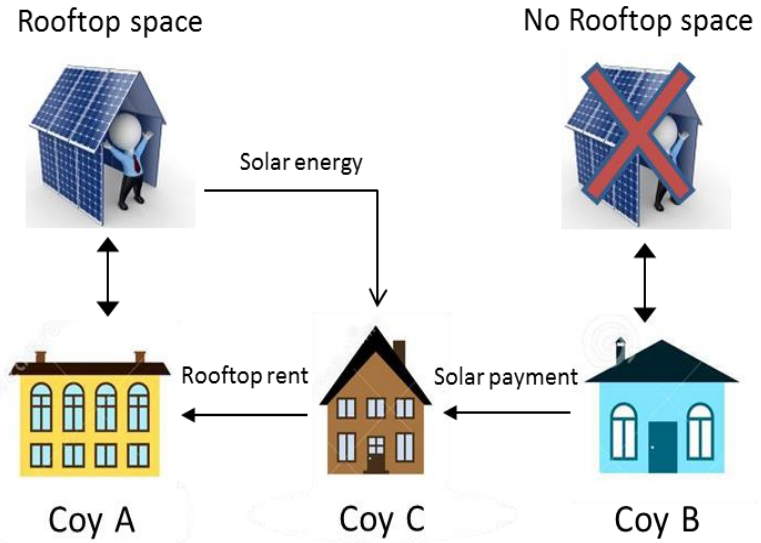


Company A has rooftop space but does not want solar energy

Company B does not have rooftop space but wants to use solar energy

After

Companies without rooftop space to buy solar energy from intermediaries who lease rooftop space for solar panels

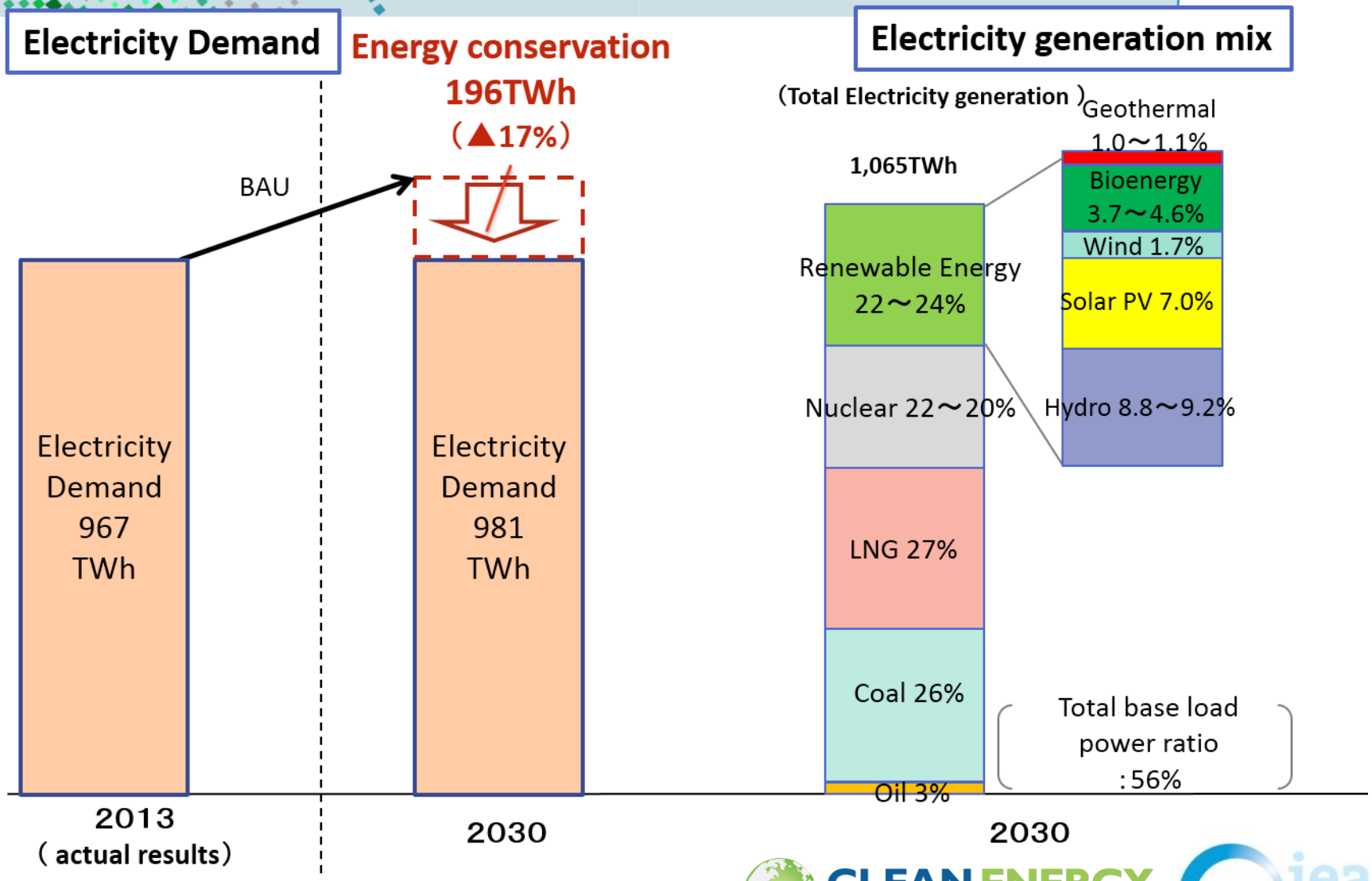


Company C can sell the solar energy to Company B

Furthermore, with the Electricity Futures Market, solar independent retailers could offer a blend of green retail contracts to suit consumers' needs.

Japan

Japan's New Energy Mix



Source) Ministry of Economy,Trade and Industry, 2015

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Power System Reforms

1st phase:
2015

Establishing the OCCTO
(Organization for Cross-regional Coordination of Transmission Operators)

2nd phase:
2016

Fully liberalizing the electricity retail market into which retail entities are able to enter

3rd phase:
2018-2020

Further securing neutrality of the power T&D sector through legal structural separation;
Abolishment of retail tariff

電力広域的運営推進機関
Organization for Cross-regional Coordination of Transmission Operators, JAPAN
OCCTO

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2nd Phase: Full Retail Competition

- Expand retail competition to the residential sector in 2016, opening a new market
- Maintain regulated tariffs to 10 big EPCOs at around 2018-2020

Liberalized Sector
(50kW～)

Large factory
Large building

Building
Medium factory

Small Factory

Share of total power: 63%

Regulated Sector
(～50kW)

Market Volume ; ¥7.5 trillion (=$ 75bn, € 54bn)
Number of contracts
Residential Customers : 76.8m
Small shops and offices: 7.4m

Share of total power: 37%

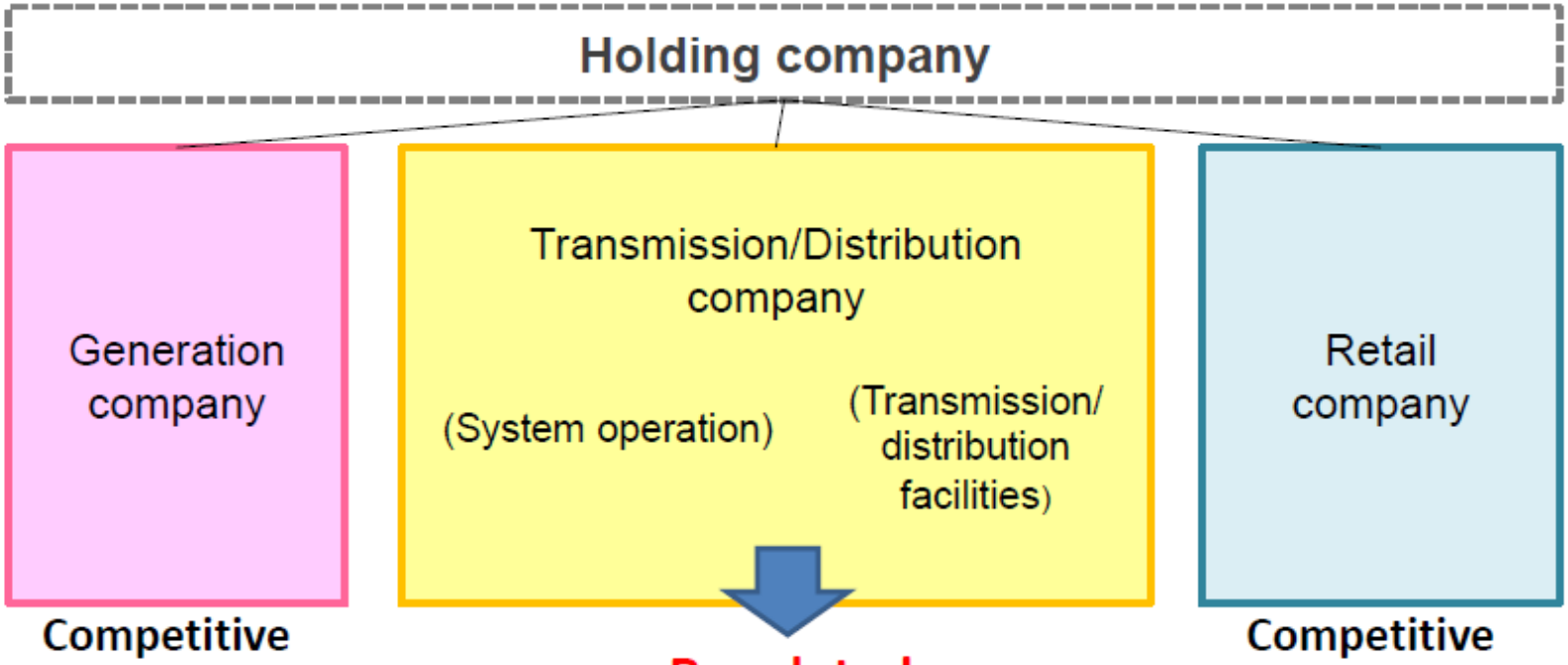
Small shop

Residential Customer

Source: METI

3rd Phase: Structural Separation

Unbundle the transmission/distribution sectors of big EPCOs by legal unbundling style at around 2018-2020



Regulated

- Regional monopoly
- Network tariff
- Responsibility for maintaining frequency & providing LR service
- Code of conduct

<Note>

- ✓ Big EPCOs will be required to unbundle transmission and distribution companies from generation ones or retail ones, in "legal unbundling."
- ✓ Both the holding company style and the affiliated company style, in which a generation and retail company has a transmission and distribution company as a subsidiary company ,are allowed.

Source: METI

NEDO's Smart Community Projects in Overseas

Lyon (France)

Smart city applications for re-developed urban area

New Mexico (USA)

Energy management for power systems with the large scale PVs

Manchester (U.K.)

Energy switching of heat consumption of households and aggregation of energy storage capability

Maui (USA)

Maximizing the use of renewable energy by managing EV charging

Java (Indonesia)

Supplying reliable quality electricity to industrial parks

Malaga(Spain)

Navigate EV drivers to charging stations efficiently considering with power system and solve traffic congestions

ENERGY MINISTERIAL

Accelerating the Transition to Clean Energy Technologies

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California Projects (1)

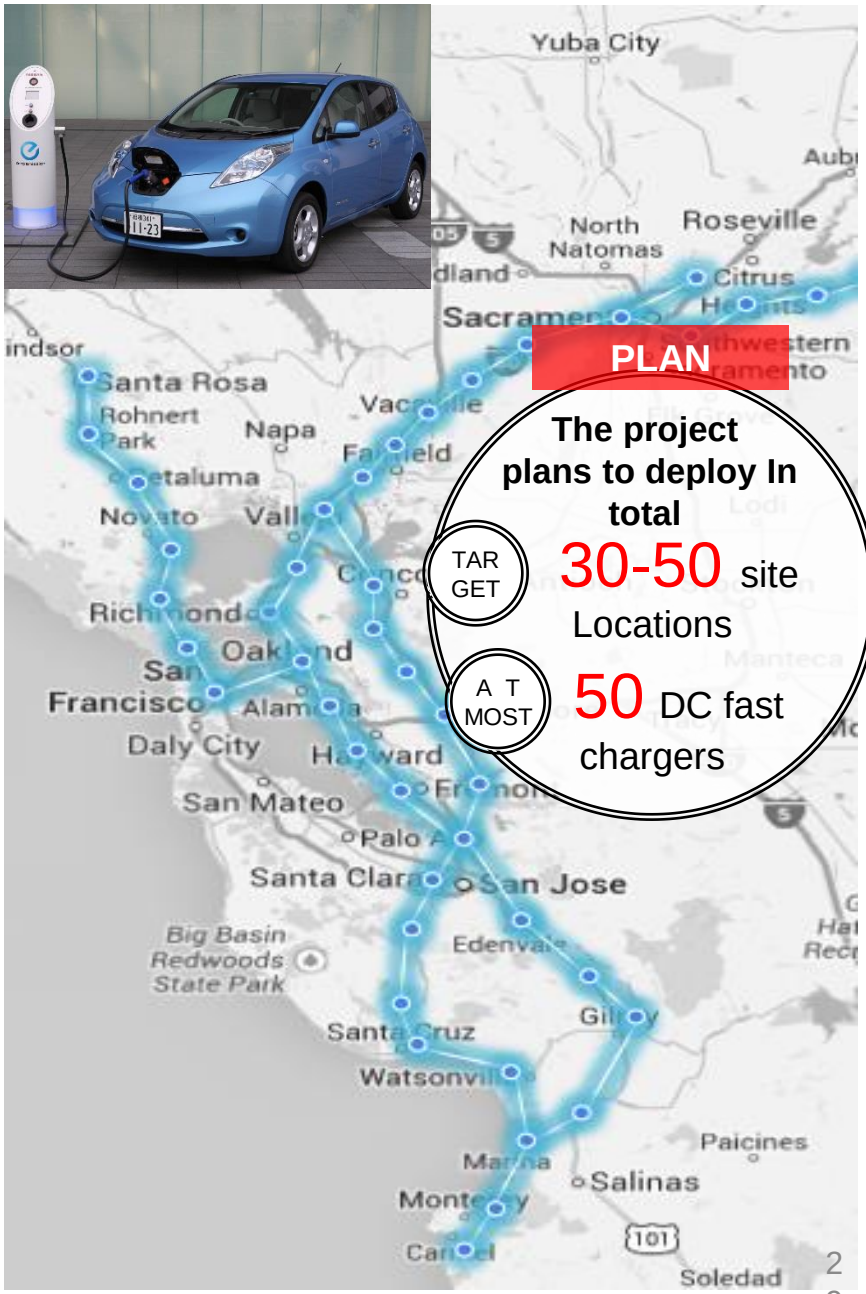
DC Fast Charging Project

1. PURPOSE

- EV driving range is shorter than that of conventional vehicles. (Range Anxiety)
- EV charging infrastructure has been mostly deployed in urban area rather than inter-city area.
- Project will lengthen EV trips, and influence EV drivers' behavior.

2. ACTION

- Planning to install about 50 Quick chargers along highways in northern California, from Lake Tahoe to Monterey.
- Analyzing EV traffic data and to study the correlation between the deployment of DC fast chargers and EV driving behavior.
- The chargers and system are to be started October 2016.

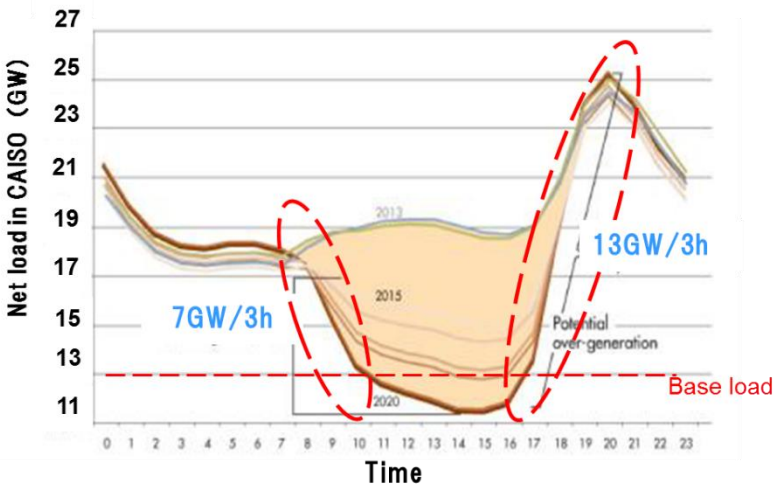


California Projects (2)

Energy Storage Project

1. PURPOSE

- The State of California has raised its RE portfolio standard to 50% by 2030.
- Energy storage will play a large role for the high penetration of RE and the reliability of grids.
- Demonstrate the benefits of the featured technology “Vanadium Redox Flow battery” to California in support of the RPS target.



Source：CAISO

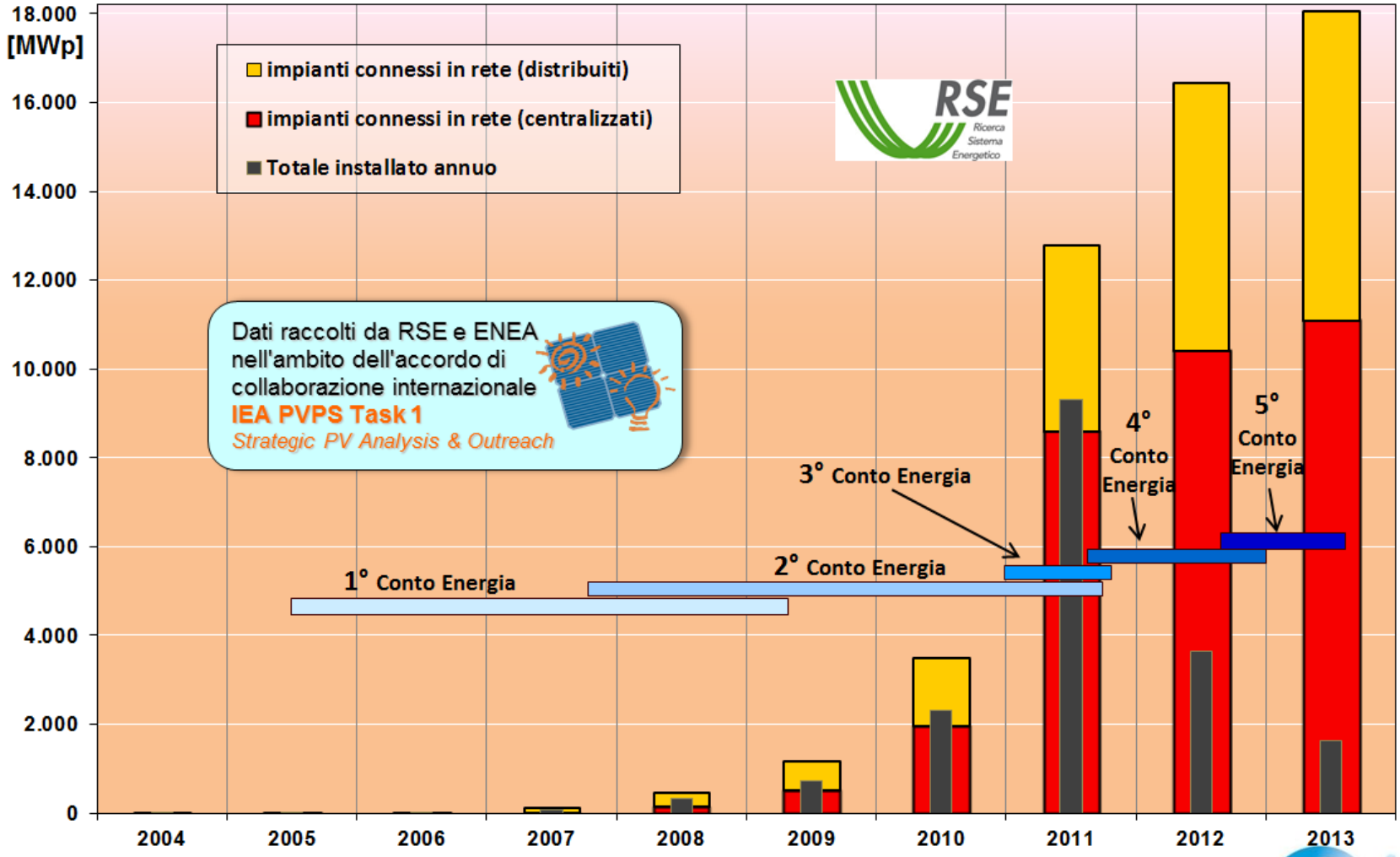
2. ACTION

- NEDO will install 2MW 4hour vanadium flow battery system at a substation site in San Diego.
- Demonstrate the unique attributes of VRF battery technology of providing multiple uses to address grid reliability issues and facilitate high RE penetration.
- The battery system is to be completed August 2016.

(Yokohama: 1MW x 5hr)

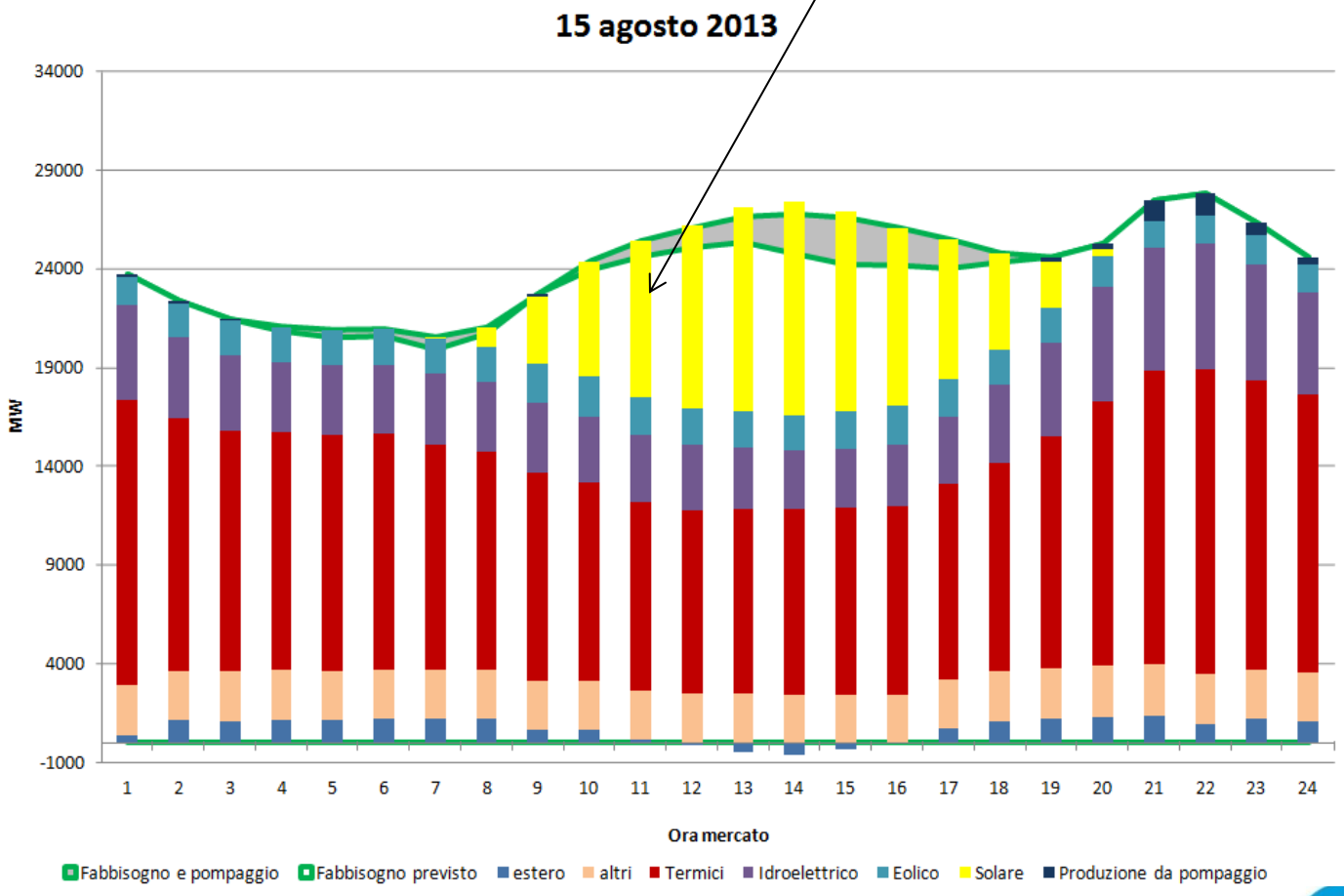
Italy

Rapid Evolution of PV in Italy



Rapid Evolution of PV in Italy

Equivalent to 10 nuclear groups !



Pilot Projects for DG Integration

Demonstration pilot: real operations in real grid (no lab)

Regulatory attention to both effectiveness (performance) and efficiency (cost): cost benefit analysis for the whole life-time of the new components

Awarded with extra-WACC (+2%) for 12 years ("input-based")

Focus on MV networks: 75% of DG rated power

Open grid: non-proprietary communication protocols only, in order to minimize interface costs for network users

Replicability and dissemination of the best practices

Active grids only: at least reverse power-flow for 1% of time from MV to HV

Real time control system at MV level: the selected MV network has to be controlled (voltage limits / anti-islanding)

Output disclosure: because demonstration pilots are paid by all customers > results must be public (no patents)

Source: AEEGSI

System Integration: Awarded projects

- Technology integration projects proposed by AEEG
- 8 projects awarded – 7 ongoing
- Several regions concerned
- Total 16.5 M€ (higher ROI rate)
- Transformation of portions of HV /MV substations and medium voltage network already experiencing reverse energy flux;
- Management of DG (dispatching, protection, supervision, automation, voltage regulation, communication);
- Pre-requisite: high replicability

Solutions Developed in the Projects

Latency tens ms

Latency 10-20 sec

Latency minutes

NETWORK AUTOMATION AND RECONFIGURATION:

- FLISR – Fault Location Isolation and Service Restoration
- Possibility to interact with prosumers (also LV) through Secondary Substation router
- Fast MV fault Isolation: Detection on isolation of MV fault sections without the tripping of the breaker at the line departure
- Anti – Islanding: detection of possible islanding condition on MV Network and disconnection of relevant generators

VOLTAGE CONTROL: Participation of MV Distributed Generation to Voltage regulation on MV feeders

- Voltage regulation trough control from secondary substation
- Voluntary involvement of prosumers in the area
- Communication between the inverters and the regulation systems
- Development of specific voltage regulators Volt/VAR
- Integration with DSO and TSO SCADA

TSO-DSO INTEGRATION: Measurement collection, DG production forecasting and data transmission towards TSO systems

ICT – THE ESSENTIAL ENABLER

ADDITIONAL FUNCTIONALITIES:

- ELECTRIC MOBILITY INTEGRATION
- STORAGE INTEGRATION
- SERVICES FOR THE FINAL USER: INFORMATION AND FLEXIBILITY

Examples of Energy Storage Projects – Italian Transmission Network

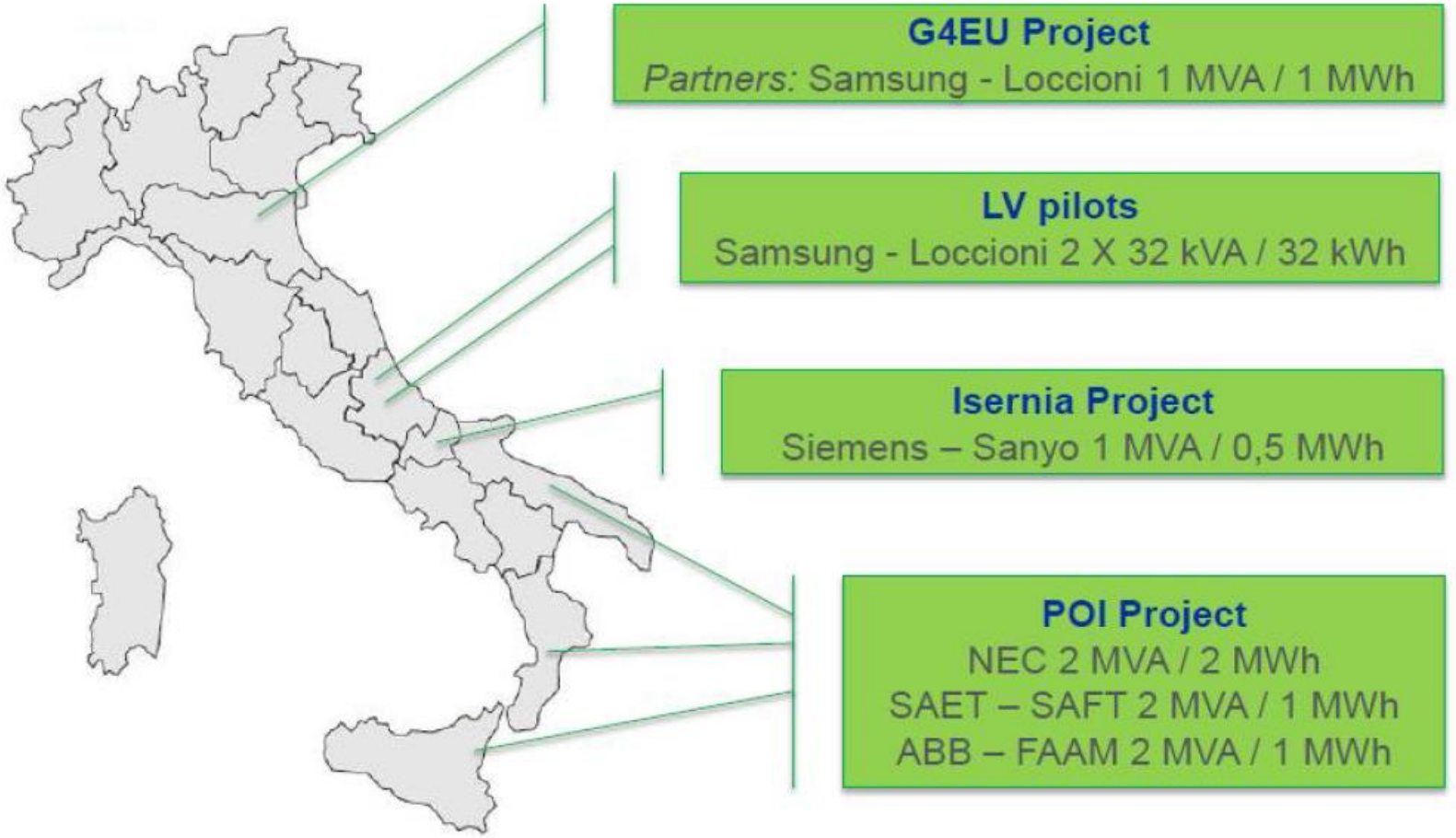
ESS Type	Description	E/P	Specific energy (Wh/kg)	Specific power (Wh/kg)	Number of cycles	DC/DC efficiency
Litio-ioni	LiNiCoAlO2 (SAFT)	0,5 – 2	108	205	3000	97
	LiMn2O4 (SAMSUNG)		65	65	5000	>97
	LiFePO4 (BYD)		100	105	4000	95
	LiNiMnCoO2 (SIEMENS)		80	160	3000	91
	Li4Ti5O12 (TOSHIBA)		73	73	6000	93
ZEBRA	Na-Ni-Cl (FIAMM / GE)	2 - 4	85	40	4500	90

Source: Terna

Started a scouting phase for 2,5 – 3,5 MW of new electrochemical storage technologies (Flow Redox, Super-cap, etc…)

Source TERNA

Examples of Energy Storage Projects – Italian Distribution Network



Source ANIE

Connection Rules of ESS to the Italian Network

A ESS must provide the following network services:

- Active power regulation
- Limitation to active power for voltage values around the 110 % of Un
- Operating in over (under) frequency conditions: the generator shall be able to interrupt the discharge (charge) cycle and, according to its state of charge, to absorb (deliver) active power. This function shall be excludable
- Participation in voltage control
- Voltage support during a short circuit (under evaluation)

Source ANIE

Examples of ESS Case Studies

ESS | Case study from the White Paper (5)

Case study: ESS stand-alone that participate in the **Balancing Market,** offering reserve band for **secondary and tertiary regulation**

Results: in the North-Central regions and in Sardinia the obtainable annual margin is limited to some tens of k€. In the other areas it's around 200-250 k€ with peak values over 300 k€ in the North area for the secondary regulation.

In the more interesting cases these revenue are obtained with a **large amount of cycles**, in particular for the technologies with a low **energy/power ratio**, with a consequent **reduction of lifetime**; **simple payback time greater than 10 years** also in the better case

For the simulations we have considered ESS with **different size and efficiency**, parameters on which realize a **sensitivity analysis**, modifying the power values, the capacity and the efficiency.

In this case study we also considered **4 different type of ESS** with typical parameters of Redox, Lithium, NaS and NaNiCl technologies

Source RSE-ANIE

Examples of ESS Case Studies

ESS | Case study from the White Paper (2)

Case study: ESS that provides the **primary regulation service instead of a coal power plant**, which can produce at **rated power** if requested by the market, instead of the 98,5% of rated power

Results: Torrevaldaliga Nord power plant, ESS of 10 MW / 10 MWh, **simple payback time around 7 years**

The following data (which refers to the period between the 1 June 2013 and the 31 May 2014) are analyzed:

- Power offered in MGP
- Energy sold on the same market
- Sell price

In this case study we considered only the data that correspond to the case in which the total power offered has been accepted

Source RSE-ANIE

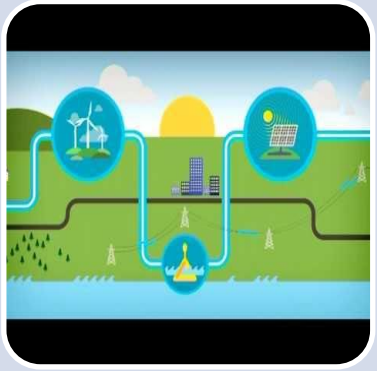
Canada

Key Drivers of Smart Grid in Canada

SmartGrid CANADA
LEADING CANADA'S SMART GRID TRANSFORMATION

Our infrastructure is aging.

- Most assets built in between 1950 – 1975 and coming to the end of its useful life.



Conservation is the cheapest way to accommodate load growth.

- New large scale generation projects are met with opposition.
- New nuclear plants are unpopular.
- Large hydro plants are limited/delayed by aboriginal land claims.

Regulators are looking to limit rate growth to no more than inflation

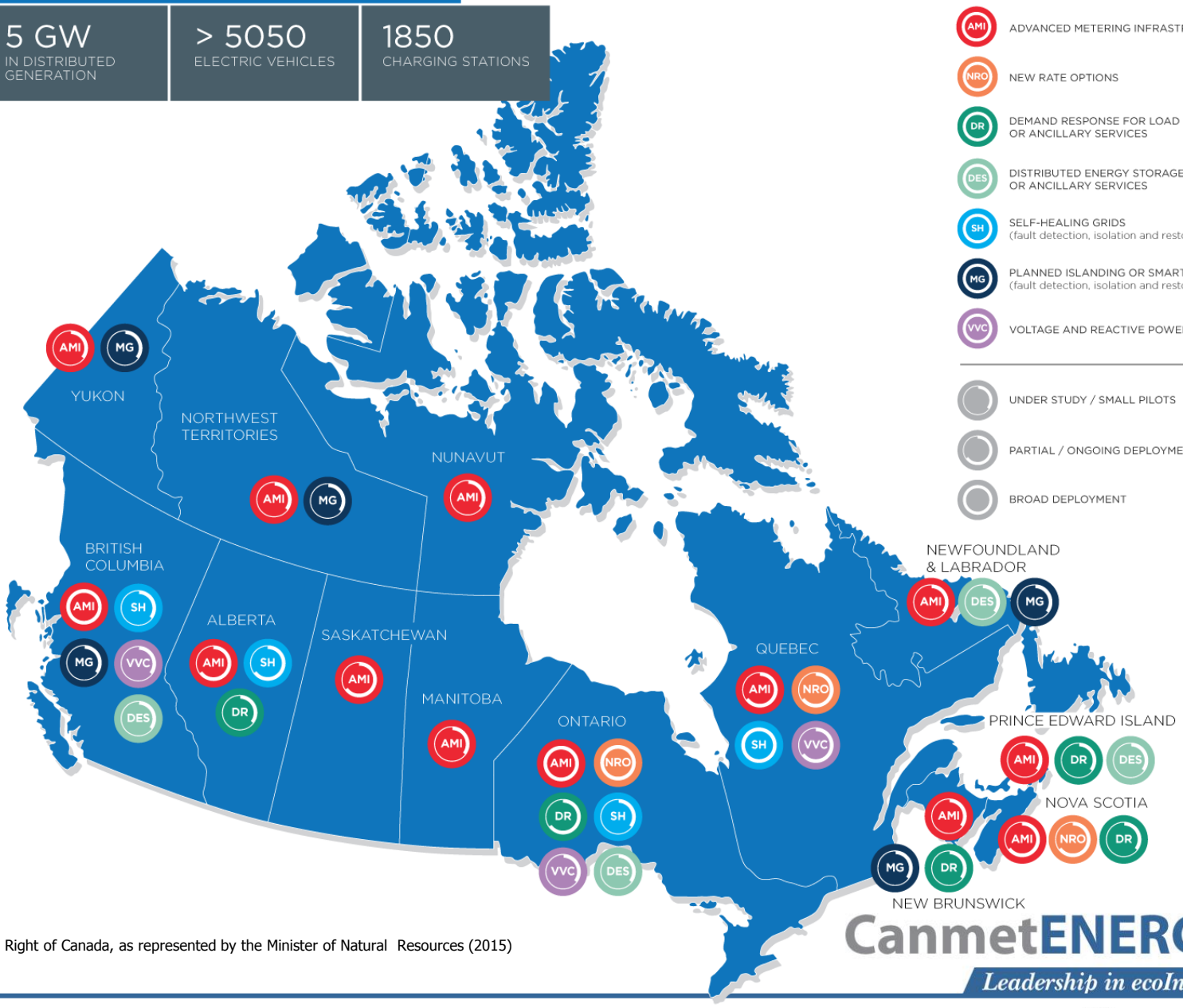
- Utilities are searching for productivity improvements from smart grid

Extreme Weather is becoming more common

- Ice storms and flooding in 2014 caused several lines to fall over with some areas having to survive without power for nearly 11 days

SMART GRID DEPLOYMENT IN CANADA 2014

67%	5 GW	> 5050	1850
OF METERS ARE SMART METERS	IN DISTRIBUTED GENERATION	ELECTRIC VEHICLES	CHARGING STATIONS



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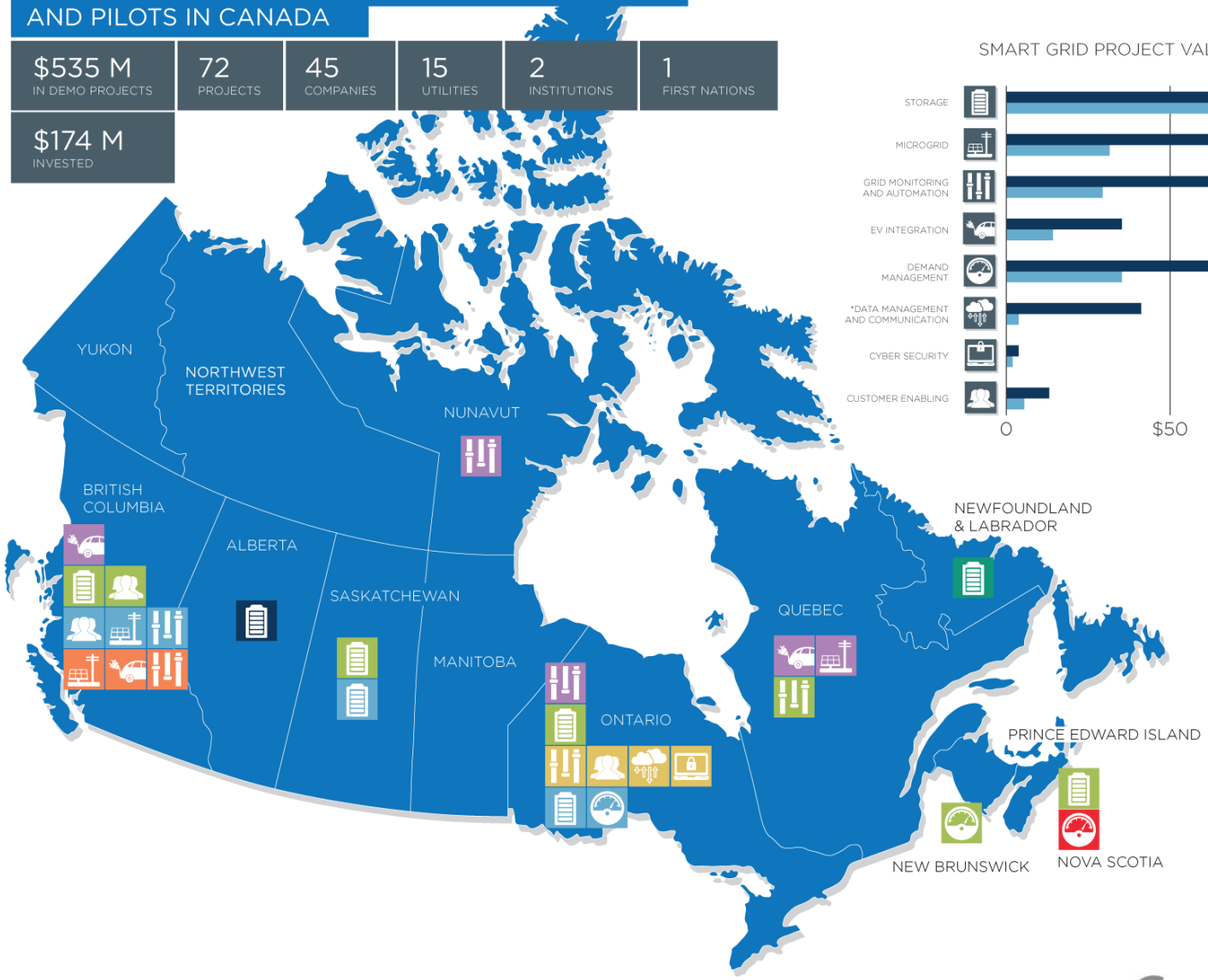
Leadership in ecoInnovation

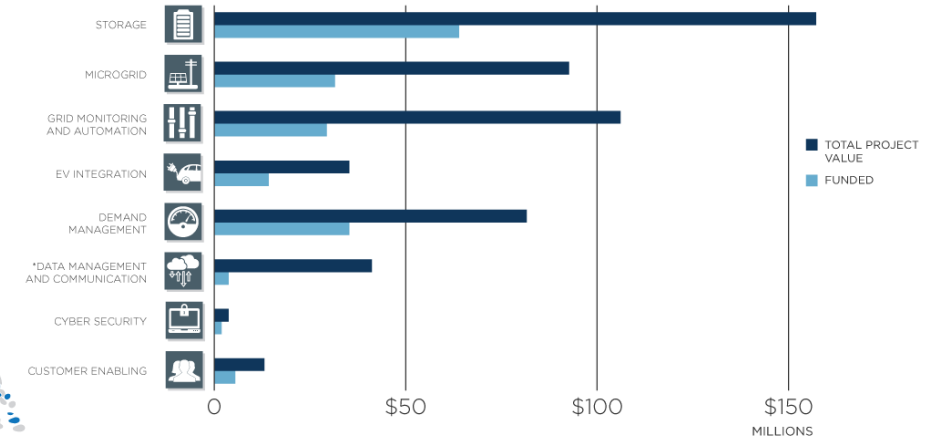
PUBLICLY FUNDED SMART GRID DEMONSTRATIONS AND PILOTS IN CANADA

$535 M	72	45	15	2	1
IN DEMO PROJECTS	PROJECTS	COMPANIES	UTILITIES	INSTITUTIONS	FIRST NATIONS

$174 M
INVESTED



SMART GRID PROJECT VALUE BY TECHNOLOGY AREA 2005 - 2014



ecoEII	NRCan – ecoEnergy Innovation Initiative
CEF	NRCan – Clean Energy Fund
SDTC	Sustainable Development Technology Canada – SD Tech Fund
GMF	Federation of Canadian Municipalities – Green Municipal Fund
ICE	BC – Innovative Clean Energy Fund
CCEMC	Alberta – Climate Change Emissions Management Corporation
SGF	Ontario Smart Grid Fund
AIF	Atlantic Innovation Fund
OCF	IESO – Ontario Conservation Fund

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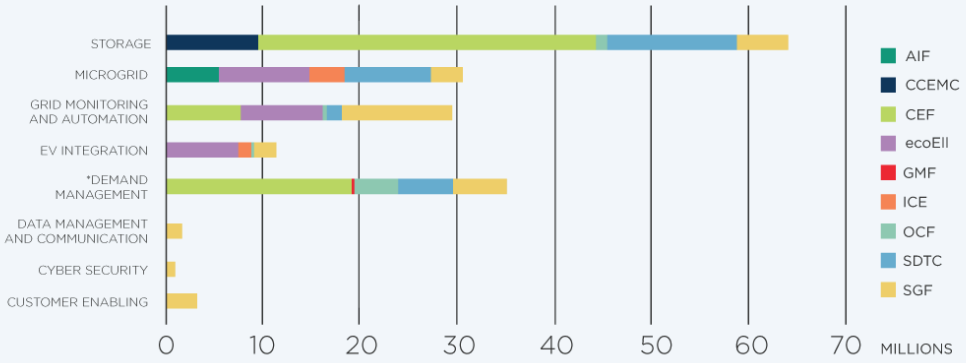
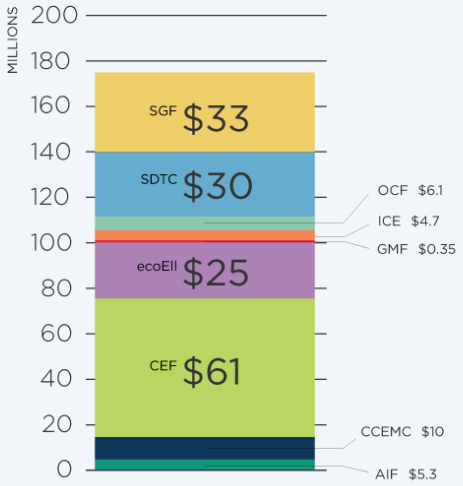
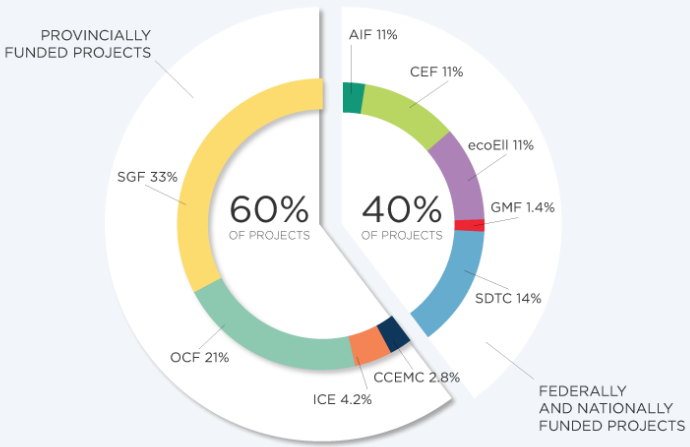
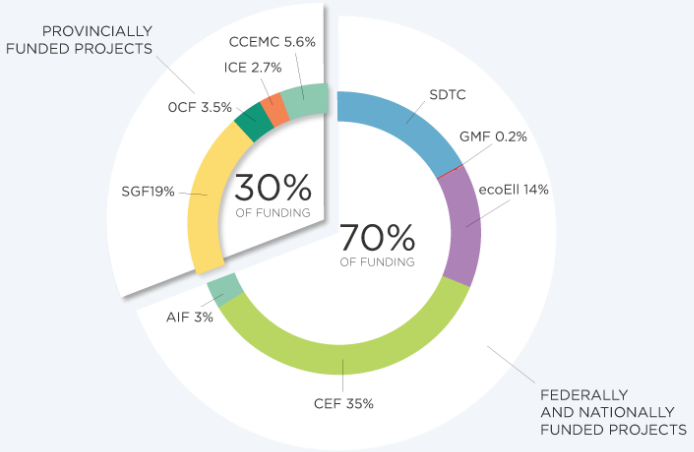
FUND COMPARISON





THE MOST FUNDING COMES FEDERALLY,
WHILE PROVINCES FUND THE MOST PROJECTS.





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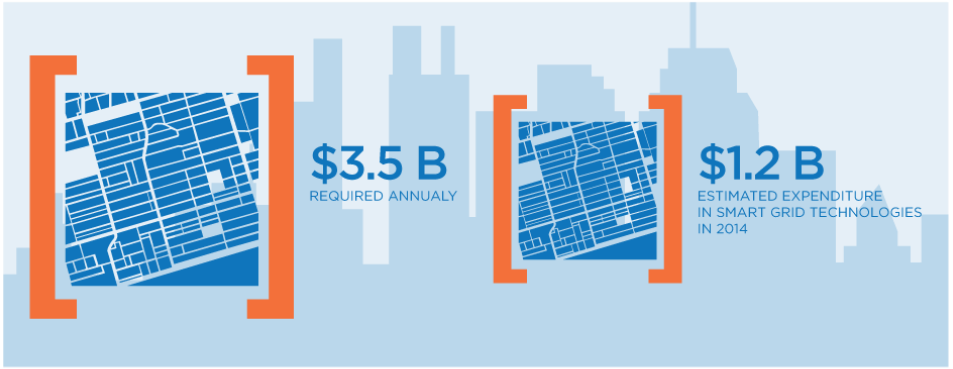
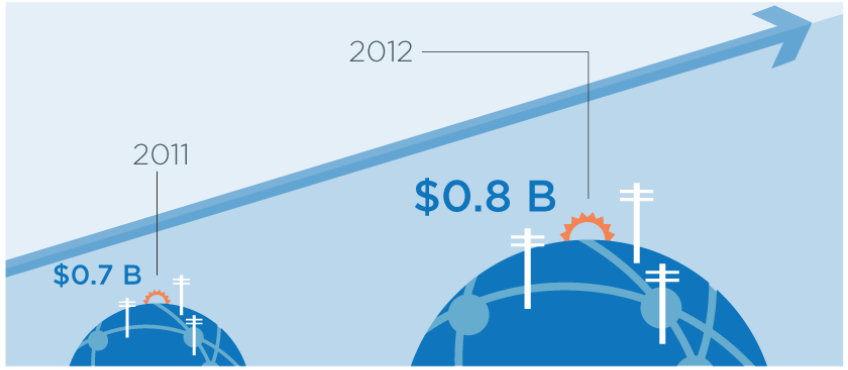
Smart Grid Outlook

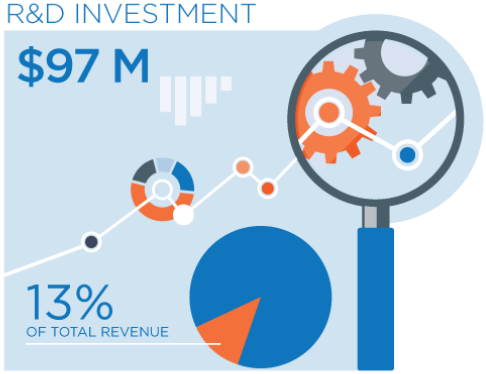
CANADIAN ELECTRICITY INFRASTRUCTURE INVESTMENT



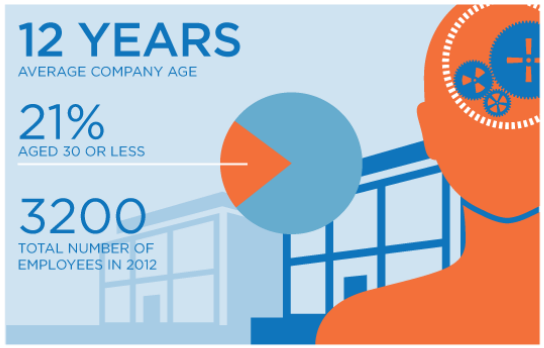
CANADIAN SMART GRID INDUSTRY REVENUE



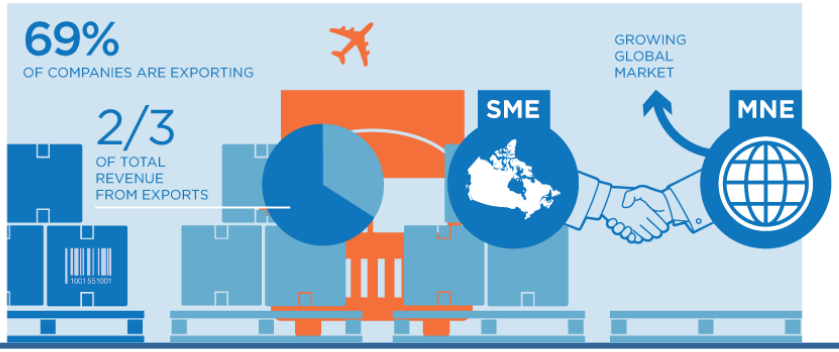
R&D INVESTMENT



YOUNG AND INNOVATIVE



REVENUES FROM EXPORTS



CanmetENERGY CALCULATED $1.2 B CAD IN EXPENDITURES ON SMART GRID IN CANADA IN 2014. THIS ESTIMATE IS CONSIDERED CONSERVATIVE AS IT DOES NOT INCLUDE ALL UTILITY EXPENDiTURES IN SMART GRID.

ALL OTHER STATISTICS ARE FROM 2012 AND USED WITH PERMISSION FROM THE ANALYTICA ADVISORS, 2014 CANADIAN CLEAN TECHNOLOGY INDUSTRY REPORT – COMPLETE EDITION, (OTTAWA) 2014.

Ontario-specific initiatives

SmartGrid CANADA
LEADING CANADA'S SMART GRID TRANSFORMATION

- Since 2011, Ontario has been building one of the most advanced electricity grids. **$50M Smart Grid Fund** was announced by the Ministry of Energy, Govt of Ontario for projects in the following areas
  - 1) Energy Storage 2) Electric Vehicle Integration 3) Microgrids 4) Behind-the-Meter 5) Data Analytics 6)Grid Automation
- View their progress here http://www.energy.gov.on.ca/en/smart-grid-fund/smart-grid-fund-projects/ .
  A 2nd round of funding was announced in 2015
- 1st comprehensive **Smart Meter rollout in North America (4.8M)**
- 1st in the world to **mandate Time-of-Use pricing (4.5M customers currently)**
  - Committed towards empowering the consumer through the **Ontario Green Button Program**. Also exploring ways to leverage data for the development of **Smart Homes**.
- Aggressive in pursuing the value of energy storage
  - 50 MW Procurement is being implemented in phases
    - Phase 1: ancillary services from energy storage resulted in IESO successfully selecting 34 MW of storage from 5 providers with 12 different projects and 4 technologies represented (Dec. 2014).
    - Phase 2: remaining 16 MW being selected to provide capacity services on-going
  - IESO is leading the effort to conduct an independent study of energy storage's value, with a focus on the bulk system.
- **EVs are an important future economic growth area**
  - As of August 2015, Ontario has over 4500 electric vehicles (EVs) on the road.
  - Utilities working on identifying new EV loads on their system, and studying the system requirements for "Smart Charging"- EV as dispatchable load & storage system.
    - 13 LDCs are currently working with Plug N' Drive to assist consumers select, purchase and install home charging infrastructure
    - Powerstream – EV studies in fleet, V2G demonstration, future integration with microgrid at head office
    - Toronto Hydro – Smart Experience EV pilot project
- Other initiatives
  - Green Energy & Green Economy Act was passed in 2009
    - Accelerated the modernization of its grid; offers generous Feed In Tariff for Renewable Energy
  - A renewed vision for energy conservation was launched in 2013; a long term Energy Plan for Ontario was released in 2013; SmartGrid Canada commissioned a 4th year of research among Canadian electricity consumers in order to better understand how to communicate smart grid initiatives and benefits to consumers.

Smart Grid initiatives by Research and Academia

SmartGrid CANADA
LEADING CANADA'S SMART GRID TRANSFORMATION

- The **Centre for Urban Energy (CUE)** at Ryerson University is progressing 34 projects aimed at developing marketable solutions to urban energy challenges in the areas of energy efficiency and conservation, electric vehicles, generation and transmission, net zero homes, policy and regulation, renewables, smart grid and storage.
- Formed in 2012, the **Southern Ontario Smart Computing and Innovation Platform** (SOSCIP) consortium of seven Ontario Universities and IBM Canada uses supercomputers and advanced analytics, agile and cloud technologies to support research and new commercial applications in critical areas including energy monitoring and management.
- **Waterloo Institute for Sustainable Energy** (WISE) is a focal point of energy research at the University of Waterloo with over 100 faculty members utilising 32 labs to lead 19 large scale multidisciplinary research projects in areas which include smart transmission & distribution systems, microgrids, EV demonstrations and large scale PV integration
- McMaster University's **Institute for Energy Studies** is actively progressing research in the areas of conservation and energy modelling, fuel cells, nuclear, solar and wind energy and supercapacitors which support EVs through its Sustainable Energy Systems Laboratories.
- **Ontario Centres of Excellence** co-invests to commercialize innovation originating in the province's colleges and universities in the segments of the economy that will drive Ontario's future prosperity and global competitiveness.

Mexico

Energy Sector Reforms

Mexico began a process of reforming the energy sector in 2013

The Electricity Industry Act define the concept of Smart Grid and instructs that for its development should be considered:

- Aspects of gradualism in its implementation, and
- The impact on rates to End Users.

Energy Transition Act establishes obligations related to the of smart grids.

To date:

✓ In 2013, a interagency working group of smart grids was established in order to align visions, exchange points of views and join efforts for the development of smart grids. In this group participate:

- The Ministry of Energy;
- The regulator;
- The System Operator, and
- The electric company.

Energy Sector Reforms

To date:

- ✓ The regulator (CRE) concluded its regulatory Route Map;
- ✓ The Utility, developed its strategic plan for the development of smart gr ids, and some AMI and PMU pilot projects .

This year, we are working on:

- ✓ **Public policies** for the development of smart grids
- ✓ **A report about**:
  - Available technologies;
  - Benefits;
  - Costs; and
  - Current state in Mexico, and their development prospects.
- ✓ **Smart Grid program**
- ✓ **Integration Smart Grid Advisory Committee,** which will replace the Smart Grid Working Group which was joined in 2013.

GRID4EU

6 Demonstrators – 27 Partners

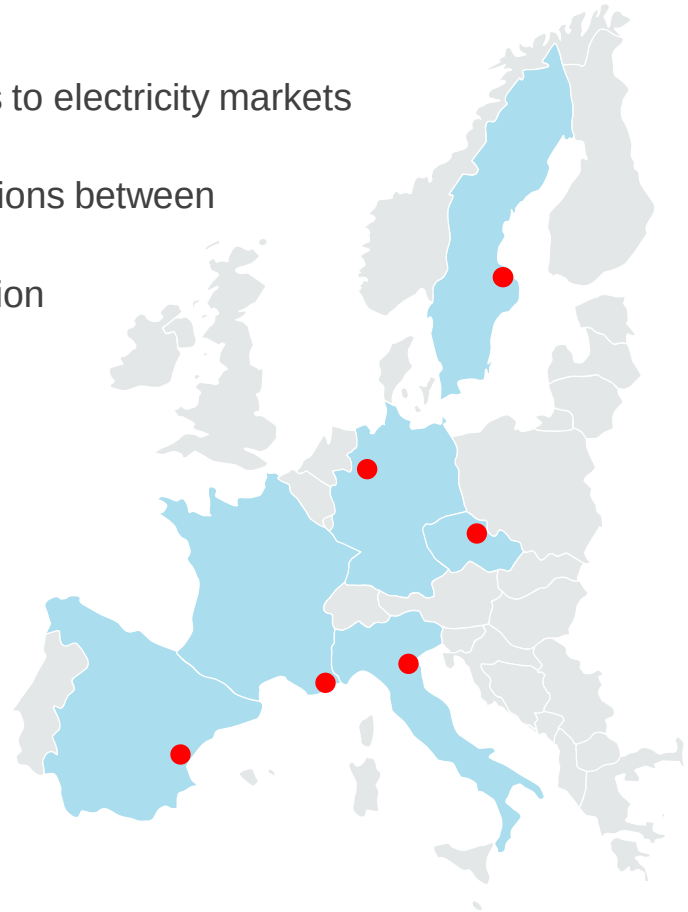
CLEAN ENERGY MINISTERIAL
Accelerating the Transition to Clean Energy Technologies

iea Energy Technology Network

Two Categories of Objectives

R&D and innovative technology Topics

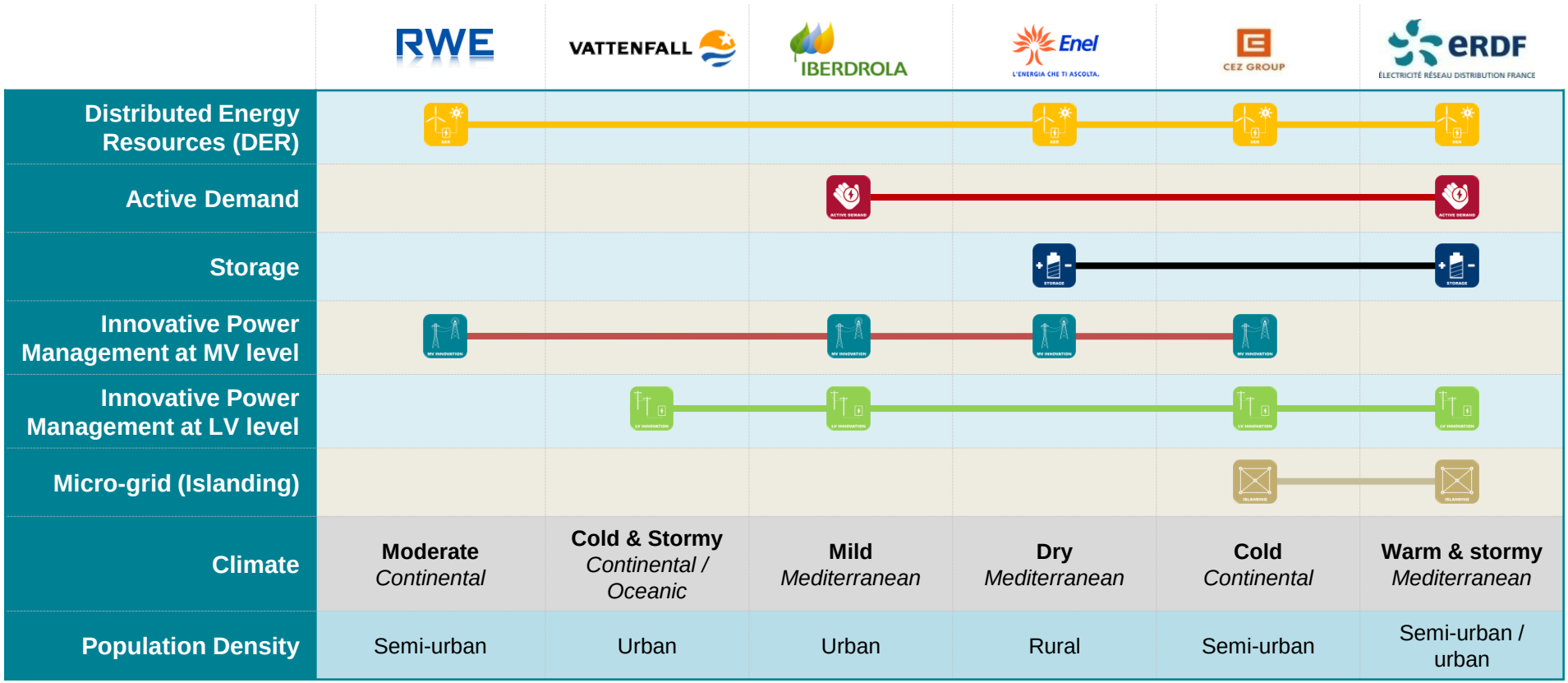
- Implementing active, more efficient participation of customers to electricity markets (active demand)
- Improving peak load management through increased interactions between network operation and electricity customers
- Using more renewable energy sources connected to distribution networks
- Secure energy supply and network reliability
- Medium and low voltage network supervision & automation
- Electric vehicles
- Storage
- Micro-grids & islanding



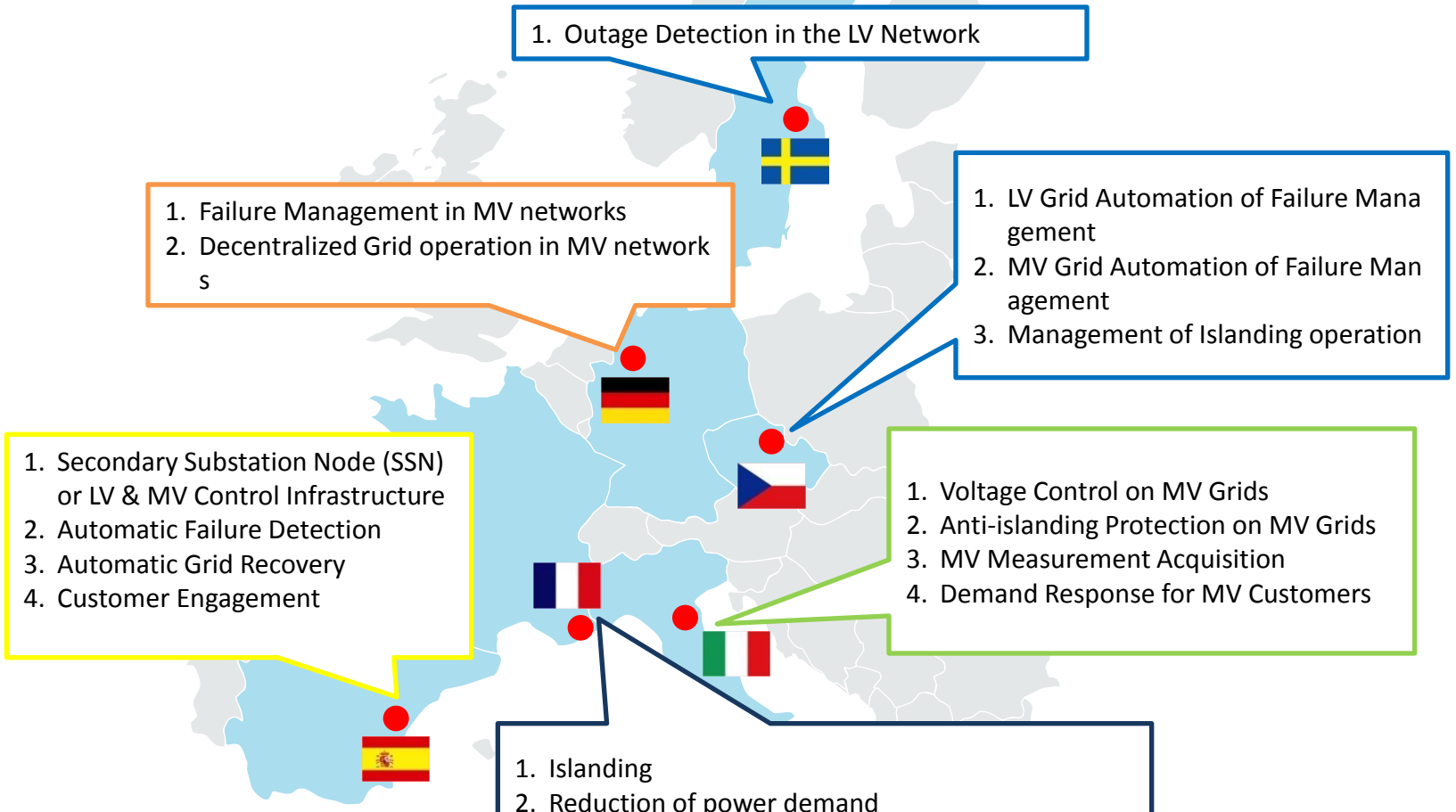
Business and Societal Topics

- Smart Grid cost-benefit analysis
- Technologies and standards
- Scalability and replicability over Europe
- Knowledge sharing

Interactions and Synergies Among Demonstrators

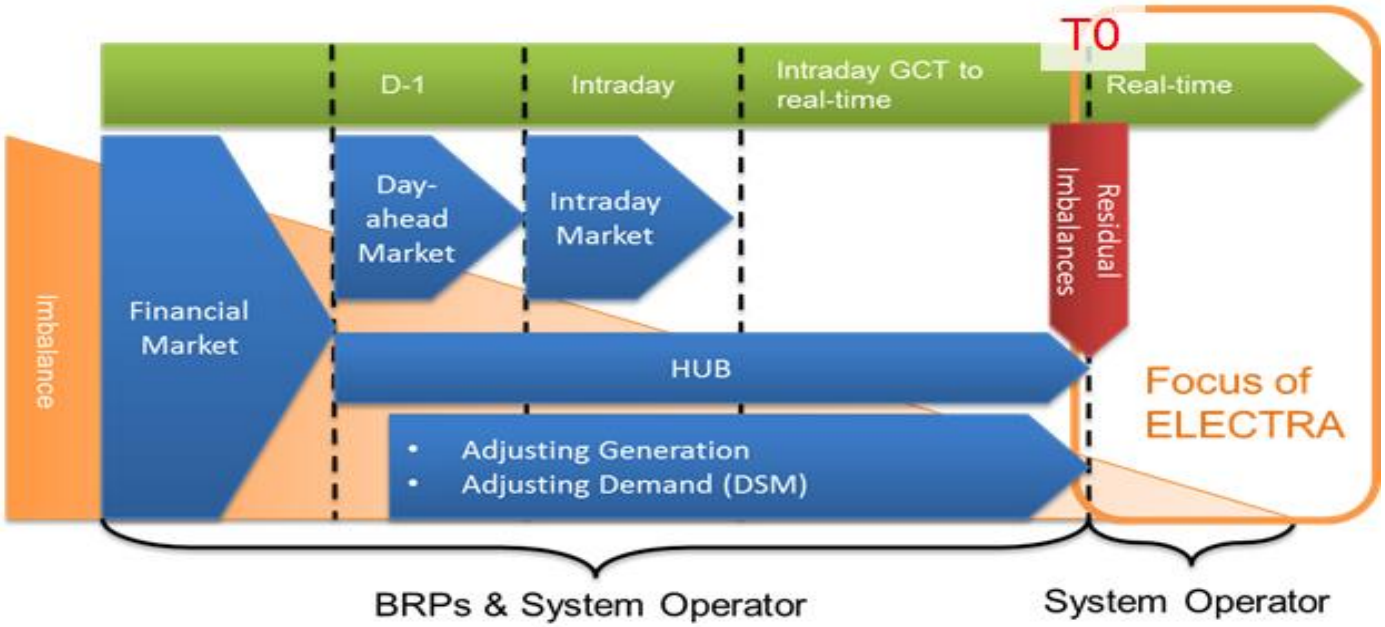


Use Cases Collection Synthesis



Technical Objectives

- The focus of ELECTRA is on providing **voltage and frequency control** services for power systems 2030+
- Develop and test **horizontally-distributed control schemes** to provide for a dynamic power balance that is closer to its equilibrium v alue than a conventional central control scheme



Why a New Architecture?

Two feasible functional architectures

Centralized managment

- The TSO remains responsible for reserves activation in its CA/CB
- To dispatch reserves at distribution, increment of observability and bi-directional TSO/DSO communication is required
- Local problems may not be noticed at TSO level. Local imbalances produced at distribution levels may counterbalance each other and at system level it can result in insecure load flows

Decentralized managment

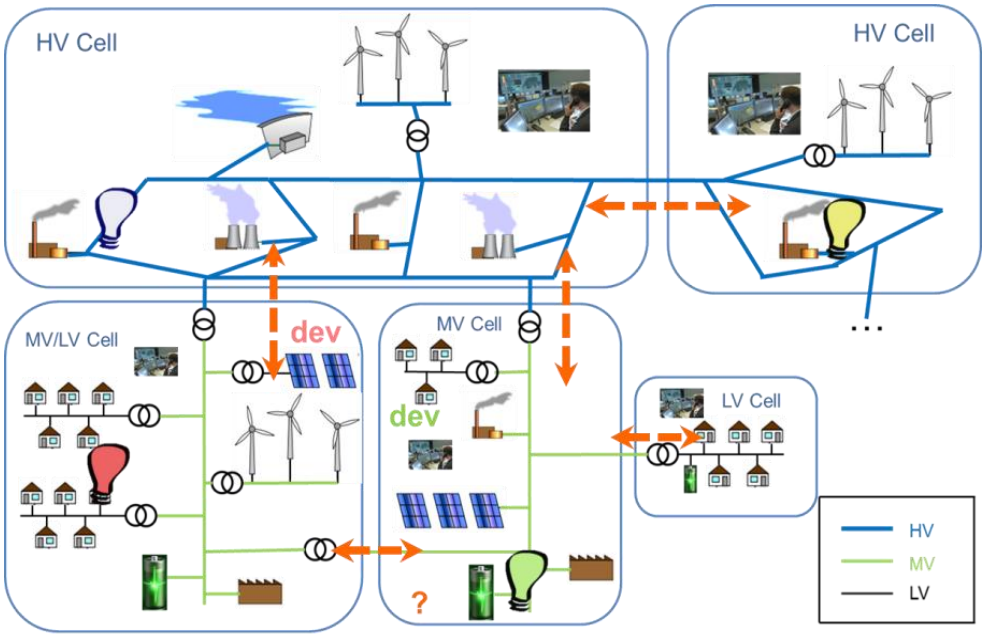
- Sub-division of the power system into **cells**, each one managed by a control cell operator
- Local problems are solved “locally”
- A cell operator is responsible for the balance within its own cell. The procurement of reserves can be done in coordination with neighbouring cells

- It allows a more flexible control
- Global reserves activation is not required

A New Grid Architecture:

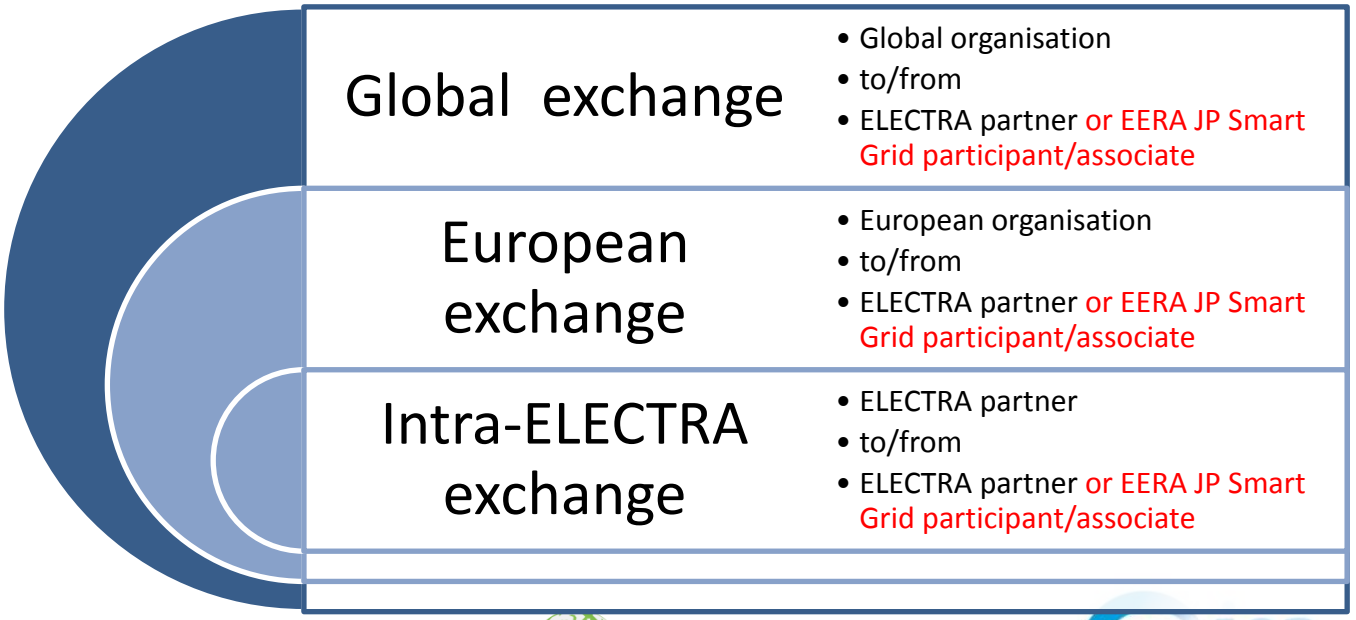
The "Web-of-Cells" concept

- Cells are connected to neighbouring cells via **inter-cell physical tie lines**; there can be multiple physical tie-lines between any two cells.
- A cell is in 'balance' when it is able to follow the **planned consumption / generation schedule**.
- Cells have adequate monitoring infrastructure installed, as well as local reserves capacity, enabling them **to resolve voltage and cell balancing problems locally**.
- A cell can contain multiple voltage levels and is managed by a ***Control Cell Operator***.



Researcher Exchange: REX Program

- Encourage use of ELECTRA REX to link EERA JP Partners with IRP activity
- Support international engagement of EERA JP
- Raise profile of EERA JP to broaden partnership
- Encourage early career networking of researchers at JP Partners

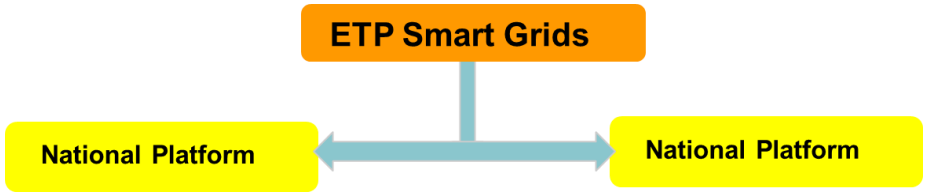


European Technology Platform

ETP SG: Mission and objectives

SMARTGRIDS

- **European independent expert organization (~150 members)**
  - Mix of academia, utilities, industry…
- **Provide a vision on technological evolutions for EC**
  - The Strategic Research agenda 2035 (2007 – 2012)
  - The ETP view on the Work Programme 2016-2017 of the EC
  - Upcoming strategic papers
- **Link between national Smart Grids Platforms and Europe**
  - National Platform Booklet
  - Flanders, Norway, Spain…



National Smart Grid Technology Platforms

- Smart Grid Webinars
- Common workshops

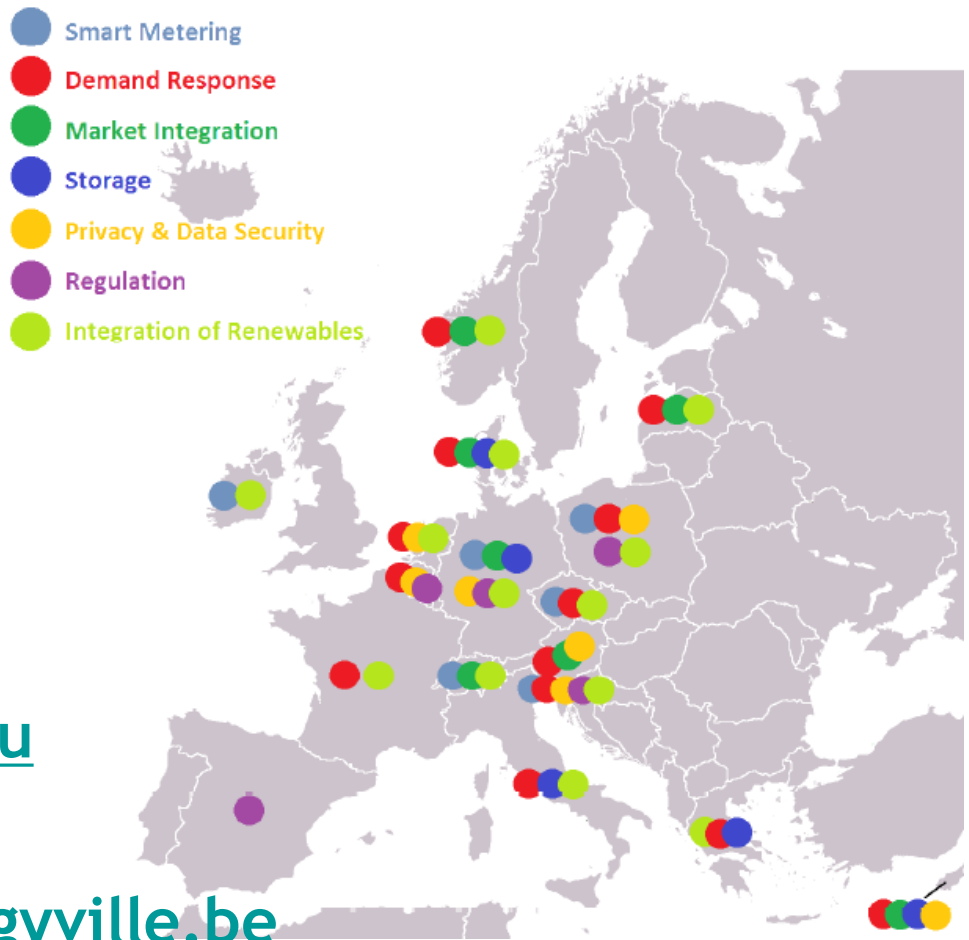
- Booklet, available on:

www.smartgrids.eu

Or via e-mail:

Secretariat@smartgrids.eu

Pieter.vingerhoets@energyville.be



Upcoming white papers

- **Digitalization of the energy system (Maher Chebbo, Pieter Vingerhoets)**
- **Asset management (Venizelos Efthymiou et al.)**
- **Network reliability standards (Goran Strbac)**

To be published and presented at the General Assembly
- 19th of May in Brussels
Register at www.smartgrids.eu !!

European ERA-Net Smart Grids Plus

ERA-Net Smart Grids Plus

From Local Trials towards a European Knowledge Community

23 funding partners from 21 European countries and regions involved

Austria, Croatia, Denmark, Finland, Flanders, France, Germany, Latvia, Lombardy, Norway, Poland, Portugal, Romania, Scotland, Slovenia, Spain, Sweden, Switzerland, The Netherlands, Turkey, Wallonia

Goal

Organize the learning to enable the right technologies, market designs and customer adoption to achieve the Smart Grids vision & goals of Europe

www.eranet-smartgridsplus.eu

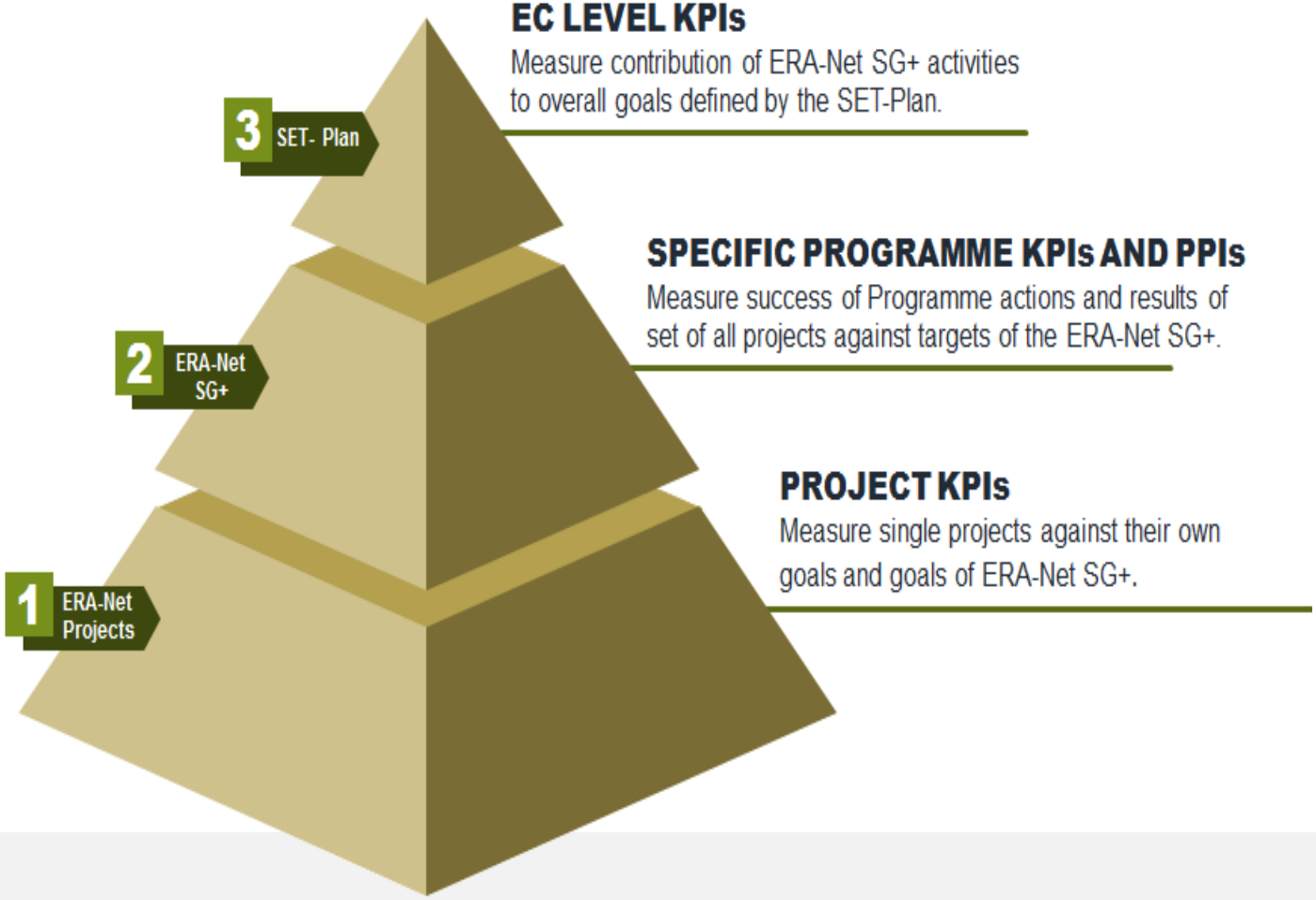
ERA-Net Smart Grids Plus will be supported by funding from the European Union's Horizon2020 research and innovation programme under grant agreement No 64603.

Smart Grids Plus ERA-Net

Sustainable European Hub for Member- States Cooperation

Profiling and Formative Evaluation on Project Level

→ Success Monitoring on Programme Level



Thank you!

For more information, please visit:

- Clean Energy Ministerial: www.cleanenergyministerial.org
- IEA Energy Technology Network: www.iea.org/techno/index.asp
- Initiatives:
  - ISGAN (CEM): www.iea-isgan.org
  - 21st Century Power Partnership (CEM): www.21stcenturypower.org
  - Electric Vehicles Initiative (CEM): www.worldevcities.org
  - Clean Energy Solutions Center (CEM): www.cleanenergysolutions.org
  - Global Smart Grid Federation: www.globalsmartgridfederation.org

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CLEAN ENERGY MINISTERIAL
Accelerating the Transition to Clean Energy Technologies

iea Energy Technology Network